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IAF Mirage 2000TH at AFS Gwalior
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Holding onto Russia

It was Vladimir Putin's visit to India in 2000 that injected significant strategic content into the India-Russia relationship after a prolonged drift in the 1990s, following collapse of the Soviet Union and end of the Cold War. Putin has returned to the top job in Moscow after he ceded the presidency to Dmitry Medvedev four years ago. His rushed Christmas-eve trip to New Delhi saw the signing of a number of agreements that covered additional arms sales and technological collaboration. Russia will sell 71 additional Mi-17 helicopters and kits for the assembly of 42 Su-30 fighter aircraft.

These deals, worth many billions of dollars, and additional plans to jointly produce helicopters in India, do not mask the difficult challenges confronting Delhi and Moscow, including in the defence sector. The endless delay in transfer of the aircraft carrier and the huge escalation in the price, have underlined the problems of defence cooperation. The Russian telecom company, Sistema, has been left in no man's land after the Supreme Court cancelled the 2G licences. Moscow has been resentful of Delhi's inability to offer redress. India's nuclear liability legislation has complicated Russia's plans to proceed with the construction of two more reactors at Koodankulam in Tamil Nadu. New Delhi has been wary of the talk in Moscow about expanding cooperation with Islamabad. Moscow, in turn, has looked askance at India's warming relations with Washington and America's expanding arms sales to India. Trade between the two countries has grown 30 per cent last year but it remains at the pitiful level of $10 billion, way below India's trade with other major powers and Asian neighbours.

Putin's brief sojourn in New Delhi did not reveal any clues on how these problems would be resolved. Nor have the two sides come up with a bold plan to boost commercial relations, which must form the foundation for any sustainable partnership into the future. Any realistic assessment of the current uncertain international and regional environment would suggest that Delhi and Moscow must necessarily hold on to their time-tested relationship. But India and Russia cannot advance only on the basis of nostalgia or mere political commitment. Tinkering and incrementalism are not enough to move the relationship forward. Delhi and Moscow must do a lot better if they want to break out of the current stasis in Indo-Russian relations.

From The Indian Express

Not on the back foot

Was it fair of the government to brush aside the Navy Day message of Navy chief Admiral D K Joshi, suggesting that it was a media goof-up? The Admiral's message merely conveyed the classical role of any navy such as ours which has a blue water capability. It is universally known that navies are meant to swiftly deploy and operate in any oceanic area where interests of the nation require it to do so. That has always been the purpose of any navy and China certainly knows this.

Frankly speaking, did the media not get it right when it linked the Navy chief's message to China's aggressive maritime posture? Rather than fault the media, we need to seriously introspect on India's timidity. Why do we always remain on the back foot when dealing with China?

The Chinese debacle of 1962 is now history and the military equation is quite different today. Yet, we are just not able to deal with China on an equal footing. What this recent incident shows is that our inferiority complex does not lie only across the McMahon Line but extends even to India's maritime dimension.

This is indeed ironic, for unlike the landward frontier with China where we find ourselves tactically disadvantaged, the situation at sea is entirely in our favour; we have an immense geographical advantage.

India's geographical location in the Indian Ocean could provide us with strategic leverage which our political leadership ought to bear in mind. With the Indian subcontinent positioned dominantly astride the vital sea lanes of communication (SLOC)- which include China's new silk route through the Indian Ocean - it is not India but China that finds itself on the back foot.

India is unable to exploit its advantage on the maritime front simply because our geopolitical attention remains consumed by the Line of Control and the McMahon Line. Our strategic compulsions vis-a-vis these land frontiers have led to a landlocked mindset, blinding us to the geographical reality that India is actually a maritime country.

In short, other countries like China have learnt to exploit the geographical facts far better than us. Moreover, using the sea is not just a matter of increasing understanding, but above all, a process of building capabilities. That indeed was the essence of Joshi's message on 4 December. The people of India would be reassured to know that ours is the only navy in the Indian Ocean region that has the capability to operate aircraft carrier battle groups and nuclear submarines.

Explaining the role of a navy has never been easy, since there is a vast difference in the way that a navy operates compared to an army or air force. Since navies invariably operate in international waters, which are open highways, they have the intrinsic advantage of being able to deploy to any part of the globe, unlike the army or air force which are confined to the nation's borders. Whilst all navies are well aware of their designated role and potential, it is the diplomats on both sides of the border who need to get attuned to the concept of naval operations. The Kargil conflict of 1999 is a case in point.

While the Indian Army and Air Force were still preparing to evict the Pakistani intruders, the Indian Navy fleets had already deployed and seized the initiative at sea. The swift deployment of Indian Navy battle groups prevented escalation and confined the hostilities to the Kargil sector. Gunboat diplomacy certainly has great possibilities.

Reach and endurance is the concern of every blue water navy, and it is for this reason that the Indian Navy regularly deploys and operates across the world in different oceanic areas. That the Chinese have a healthy respect for the Indian Navy's capability has also been well established.

In September 2000 when the Indian Navy deployed a task force of submarines and destroyers to exercise in the South China Sea, there were misgivings in certain political circles. To those who understand what sea power is all about, it came as no surprise that this task force, which operated for more than a month in the region, was finally received by the Chinese at Shanghai naval base with full military ceremony.

Not many would know that the year 2012 is a historical landmark for the Indian Navy, for it came into being exactly four centuries ago, commissioned by the British East India Company in 1612. From a ragtag marine force, the navy is today a blue

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water force with potent capabilities. This is the sort of maritime heritage that would make any nation proud and is surely what every Indian would like to hear.

Admiral Joshi's reassuring message on our Navy's 400th anniversary was essentially meant for the people of India. That such a message was misconstrued as a diplomatic faux pas clearly shows that we have a scant understanding of what sea power is all about.

Perhaps we need to learn why the Greeks of antiquity and the emperors of ancient Rome went about building their navies even though it was an era of continental wars. If we do not want to fail the test of sea power as happened with Alexander, Napoleon and Hitler, it is time that we in India understood the purpose of a navy.

Admiral Sushil Kumar (R)
From The Times of India

The Russian Connection

Although India now buys its defence hardware from a range of countries in addition to Russia, the Indo-Russian defence relationship remains stronger than ever. Instead of fighter aircraft, tanks and air defence guns, Russia is now India's prime source for "sub-strategic" systems that incorporate closely guarded technologies. These include the nuclear-propelled submarine INS *Chakra*, which Russia has provided on a 10-year lease; the aircraft carrier INS *Vikramaditya* and potential access to the precision code of Russia's Global Navigation Satellite System. After jointly developing the BrahMos supersonic cruise missile, the two countries are joining hands to develop next-generation systems for both their militaries, like the Fifth-Generation Fighter Aircraft and the Multirole Transport Aircraft. Russia has also helped India develop its own nuclear-propelled ballistic missile submarine.

Although the defence relationship has recently made headlines for negative reasons – cost escalations, time overruns and serious glitches in technology transfer – it remains not just a positive driver of Indo-Russian relations, but increasingly the primary one, along with the other two strategic fields of space and nuclear co-operation. With trade relations languishing, Moscow playing hardball with Indian hydrocarbon companies, and the Sistema row roiling relations, the defence relationship is a reliable sheet anchor that steadies the overall partnership.

Importantly, given the wariness that characterises relations with China, any distancing from Russia would make India appear uncomfortably like a western ally. With Russia growing politically closer to China and increasingly dependent on the Chinese economy, strong Moscow-Delhi defence ties give Russia the strength to keep China's defence industry at arm's length. Moscow's ambitious State Armament Programme aims at practically re-equipping the entire Russian military by 2020 at a cost of $650 billion. This requires developing a whole menu of new-generation systems and technologies, something that Moscow cannot fund on its own. The trust between Moscow and New Delhi makes India the ideal partner for co-development, with the cost and the technological risk shared by both of them rather than absorbed purely by Russia. Furthermore, the vast requirements of the Indian military, combined with Russia's own modernisation drive, provide the economies of scale needed for both militaries to obtain high-tech, low-cost systems.

Beijing's institutionalised embrace of reverse engineering means Russian technology czars prefer India, which buys cutting-edge systems and customises a few key sub-systems to suit its own requirements. While India benefits from Russia's superior technology and experience in building advanced weaponry, working with a senior partner could create an undesirable dependency unless there are clear systems in place to ensure that technology is absorbed by Indian engineers. New Delhi has also realised that there are times when it has to accept delays and cost increases. There are geopolitical and military advantages of a close relationship with Russia, but New Delhi needs to deal with the disadvantages that are evident at the transactional level and shape the relationship to both parties' advantage.

Ajai Shukla
From Business Standard

Real race against time

The economy has turned in another weak quarter with the gross domestic product (GDP) growing 5.3% in July-September. This is the third successive quarter when the GDP has grown at around these rates and it is likely the growth rate for the entire fiscal year will settle at around the 5.8% projected by the Reserve Bank of India in its latest review of monetary policy. The difference between 6% growth and the 8% Asia's third largest economy had accustomed itself to shows up in a very real sense in the number of jobs it is creating. Every fourth Indian entering the workforce next year will not have the job he could have had if the economy were growing at 8% instead of 6%. For as long as he has to live off his family, the household savings dips, thereby reducing the economy's ability to grow faster in the future.

Sub-six per cent growth is an aberration the government must rectify fast. The real economy has capitulated to high interest rates brought on by runaway inflation. Farming is coming to grips with a delayed monsoon and some of the impact is visible in this quarter's data. Factory output is frozen and now services are stalling. The only sector holding out is finance and here the government's borrow-and- spend policy is playing out in the statistics. The government co-opts almost all of household savings and this shows up in the other head of social services when it spends that money. Reports from the rest of the services sector are stark: cargo handled by ports is down by 0.9% and airlines flew 6.3% fewer passengers in July-September 2012 than they did in the same three months a year ago.

It has been obvious to observers, notably the central bank, for some time now that the government will have to get its expenditure under control before the economy can step back on to a higher growth path. The RBI has made lower interest rates conditional on fiscal rectitude and the government has reacted by biting the reform bullet. Subsidy diversion is being trimmed through innovative cash transfers, an efficient goods and services tax is back on the table and infrastructure investments are sought to be put on the fast track. Finance minister P Chidambaram has committed himself to a fiscal consolidation roadmap even as the government gears up for a general election. But all of this is a race against time. The RBI does not see inflation cooling off enough for it to be able to cut interest rates before the fourth quarter of 2012-13. Till then the economy will be starved for credit, and investments, by the government's welfare burden.

From Hindustan Times

SAAB

The Boeing AH-64D Apache is being ordered by India for operation by the Air Force – or Army?

SHARING THE PIE IN THE SKY

Admiral Arun Prakash writes on the ownership of attack helicopters

The recent decision of the Ministry of Defence (MoD), setting to rest the long drawn out controversy regarding the ownership of attack helicopters has not come a day too soon.

It is to the credit of the present Raksha Mantri that he decided to "bite the bullet" which many of his predecessors had chosen to dodge, either because they could not spare the time to deal with such a complex issue, or because they were unable to muster the Solomon-like wisdom required to pass judgment on a matter of such contention between two Services. As recent events have shown, the detachment of our elected representatives from national security issues invariably leads to serious consequences.

It is to be hoped that this decision was neither ad hoc, nor stop-gap in nature. Otherwise, it will mark merely a "cease-fire" in the turf battle between the Army and the Indian Air Force. However, if the MoD has, indeed, analysed the issues involved, and logically established the principles and rationale that underpinned this landmark ruling, it could provide guidelines for the resolution of any future inter-Service disputes of this nature.

The IAF, like many other air forces, has been seeking a formal delineation of aviation "roles and missions" and nomination of "core competencies" for many years. This demand is justified because there has been a proliferation of aviation wings, not just amongst the three Services, but also in the Coast Guard, para-military forces and intelligence agencies. Consequently, there are demands for additional aviation assets and personnel, as well as instances of territorial overlap and even conflict between operators.

This is not new, because air power has been the cause of fierce controversies and debates over resources, roles and missions as well as institutional boundaries ever since the second decade of the last century. Two early and vociferous proponents of air power, Air Marshal Trenchard in Britain and Brigadier Douhet in Italy put forth propositions which carried conviction with contemporary decision-makers. According to them, air power was an "indivisible" entity which deserved the status of an independent Service in parallel with the navy and the army. It was also their belief that used for strategic bombing, as a stand-alone strategy, air power could demoralise civilian populations, decimate industrial bases and win wars by itself.

Notwithstanding strong empirical evidence to the contrary, in WW II as well as subsequent conflicts like the Vietnam War, the idea that strategic bombing, alone, was the path to victory, has endured in modern warfare. In the post-Cold War era, a number of military interventions by western powers have given air power a new aura and profile. Terminology like "strategic paralysis", "shock and awe" and "air dominance" has come to be associated with the aggressive deployment of air power.

A hundred years after Douhet and Trenchard, the IAF continues to subscribe to their belief in the indivisibility of air power, but has substituted strategic bombing

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with the new "air dominance" paradigm. It is now being heard that modern air power may have rendered ground forces obsolete, and quick military victories can be won after establishment of air dominance, at little or no cost to lives. In such a paradigm, close support of land and maritime forces is seen as superfluous and receives low priority.

There is need to tread with caution here because of some flawed premises. Firstly, all the recent conflicts involving air power in Iraq, Afghanistan, Kosovo, Lebanon and Libya have been asymmetric, involving on one hand forces which had the benefits of advanced technology and on the other, adversaries with little or no air power and outdated weaponry. More importantly, in none of these conflicts has victory been swift, decisive or cheap. India, on the other hand, is faced with well-equipped, technologically competent and highly motivated air forces and in our calculus we can neither bank on any specific advantage, nor speak nonchalantly about attaining air dominance.

All three of India's armed forces must, therefore, be prepared face the full brunt of sophisticated enemy air power in operations, whether they seek to place "boots on the ground", attain "sea control" or "air dominance". They must also bear in mind an important lesson from 20th century conflicts - that wars are won and lost neither at sea by navies, nor in the air by air forces, but on the ground by armies. If this be true, should the attainment of air dominance become an end in itself which replaces military and maritime strategies? Or should air power be seen as merely a powerful instrumentality to gain operational objectives on land, sea and air by the three Services?

The essential question boils down to whether we should blindly adopt the operational philosophies developed by western air forces or evolve an India-specific approach to air power based on our own experiences. Well-known US air-power analyst Benjamin Lambeth, in his recent monograph on the Kargil war, makes this telling comment on the state of IAF readiness for the conflict: "Without question, the unusually demanding challenges presented by the operation made for a sobering wake-up call for the IAF, which evidently had not given much prior thought to such a scenario and had not trained routinely at such elevations until it was forced to do so by operational necessity." The onset of war is hardly the time to start training, and this is a clear indication of doctrinal voids as well as lack of political direction in our national security paradigm.

In the light of all these questions, it becomes necessary for the MoD to give serious consideration to the long-standing IAF demand for a debate on aviation roles and missions. For too long have we treated this issue as a "holy cow" and shirked from free and frank discussion at a high level. A brief glimpse into recent history of the US armed forces would demonstrate how elected representatives, in other countries, involve themselves in the resolution of vital national security issues of such a nature.

The traditional dividing lines of responsibility between the army and navy, whereby one operated over land and the other at sea, were demolished by the advent of military aviation. The lines became further blurred in WW II when both the US Army and Navy deployed aviation wings for support of their operations. Soon after end of the war, passage of the US National Security Act of 1947, which unified the armed forces and created the US Air Force as a separate military service, further complicated matters.

While the Act assigned general roles to the three Services, a Presidential Executive Order spelt out details of "roles and missions". The Navy was made responsible for control of the sea and the air above it and the Air Force was responsible for combat in the air, including strategic bombardment, airlift, and tactical support of ground and naval forces. However, the US Navy objected, because if missions were defined in terms of medium of operation (land, sea, air), it constituted a threat to naval aviation.

Seeing the necessity of addressing the contentious issue of roles and missions, in March 1948, the US Secretary (Minister) of Defense gathered the service Chiefs and, together, they hammered out a new set of roles and missions. Subsequently, these were enshrined in Title 10 of the US Code of Federal Laws which remains the legal basis for Service roles and missions.

Air power has, unquestionably, become intrinsic to every form of military operations, on land, at sea or in the air. While "indivisibility of air power" may have been a good hypothetical construct in the past, the question that begs an answer today in India is this: how is air power to be deployed or shared to fulfill the vital operational needs of the army, navy and air force? It is only when one looks at changes taking place world- wide that one realises the time-warp that our armed forces are stuck in.

For example, a Strategic Defence Review (SDR) was undertaken in the UK in 1998, with the objective of enhancing operational effectiveness, cutting costs and eliminating duplication. One of the major outcomes was a directive to the British armed forces to pool their helicopter assets to form the Joint Helicopter Command (JHC). With nearly 300 helicopters flown and maintained by tri-Service crews, the JFC is commanded, in rotation, by two-star officers of the navy, army and the air force, and has seen successful operational deployments in Iraq and Afghanistan.

Most democracies periodically conduct Strategic Defence Reviews or issue defence White Papers which clearly highlight national interests, identify vital goals and objectives, and undertake an appraisal of the security environment. A deliberate exercise of this nature helps visualise the kind of armed forces the country needs, and pinpoints the specific capabilities the need to field. In India we undertake no such introspection and continue to indulge in wasteful expenditure because we have failed to integrate our armed forces. We are also stuck with inefficient and dysfunctional structures for management of defence which will let us down in war.

Unfortunately India suffers from a twin handicap in the national security context.

Firstly, most of our elected representatives have little interest in security matters and this becomes evident from the manner in which the voluminous proceedings of the Parliamentary Standing Committee on Defence lie unread and its recommendations un-actioned by Parliament. Secondly,our over-worked and under-staffed MoD lacks the expertise, time and inclination to undertake reviews or evaluation of armed forces structures, doctrines and force-planning philosophies. The option of constituting independent "expert committees" has never been considered.

Until some change comes about, it is incumbent upon the Service HQs and the Integrated Defence Staff to apply themselves seriously to doctrinal and strategic issues. For example, they could work on concepts for the conduct of the joint "Air-Sea Battle" and the "Air-Land Battle in the Mountains". The numerous Service institutions of higher-learning and the captive think-tanks too could be mobilised for such intellectual endeavours. Perhaps then we may be able to harness inter-Service synergies, instead of squabbling over hardware.

IRKUT

Security In The Balance

The Kargil review committee, chaired by the late K. Subrahmanyam, was followed by the setting up of four task forces. One of these was on defence management, chaired by LK Advani with other members being George Fernandes, Jaswant Singh and Yashwant Sinha,with Brajesh Mishra, the then national security adviser, as a permanent invitee. The aim of this task force was to review the national security system in its entirety. It submitted a report titled, *Reforming the National Security System*, in February 2001, which, after deleting some security related sensitive issues, was released to the public.

An unusual addition to the report was a prefaced quote from *Sukraniti* in Sanskrit along with its translation that read: "[N]othing remains, neither the state nor wealth and valour without the security provided by the armed forces. One should never forget that while the strong control all, the weak have many enemies."

To the students of national security long used to seeing the armed forces of India being treated as an unnecessary burden by the political and civil service leaderships, this preface provided at least some amount of recognition.

The group of ministers noted the lack of a formal structure in India which could provide a synergy between academic research on security issues and the government's security policy formulation. It recommended the setting up of a national defence university. As a follow up, the ministry of defence formed a committee on national defence university (*Condu*) in July 2001. This had three retired officers of the rank of general representing each service, one serving general from the integrated defence staff and one security specialist from the national security council secretariat. In addition, there were four professors and three PhD scholars chosen from across the wide spectrum of security, governance, management, technology, economy, academia and industry. The committee was chaired by noted strategic thinker, K Subrahmanyam, with a joint secretary of the defence ministry as member secretary.

Arun Singh, the erstwhile minister of state for defence and one of the keenest minds on security, played an important role in the selection of members of *Condu*. A report was submitted to the defence minister after extensive visits to various establishments within the country, the USA and the Chinese national defence universities and sustained interaction with experts from diverse fields, the chiefs of staff committee and the defence ministry.

On the need for the proposed Indian national defence university (*Indu*), the committee noted that in spite of being faced with a highly complex and dynamic security environment, both nationally and internationally, India had been neglecting national security as a discipline to be studied seriously. It felt that the challenge

was to educate and adequately prepare national security leaders to enable them to look at strategic security challenges holistically and formulate policies based on researched and informed inputs. It further noted that the practice of joint military-planning and operations involving all the services remained neglected even though such exercises help in forging of links with military officers of friendly foreign countries.

The committee proposed an organisational model for *Indu* where educational centres would work closely with associated research facilities on national security related issues. There would be a move to modify the existing armed forces institutions to meet the needs of *Indu*. While two-thirds of all participants in *Indu* colleges were to be from the armed forces, the remaining one-third would come from the civil services, police and others. The faculty was to be divided equally between the military, civil services and academics. The aim would be to nurture a pool of defence and security practitioners, policy makers, faculties, think-tanks and so on to ultimately add weight to strategic thought, debate and, finally, informed policy-making.

How painfully slow the process of national security policy formulation becomes evident from a recent statement of the defence minister in the Lok Sabha. He informed members that the union cabinet had, in its meeting on 13 May 2012, given its approval to the setting up of *Indu* at Binola in Gurgaon and projected that the entire process of establishment of the university would take about seven years.

So if all goes as per plan, the nation will be fortunate in having established a defence university that will come into being two decades after the Kargil conflict. However, educated, informed and strategised security planning, policy-making and integrated war-fighting will only follow some years later, as more of our security thinkers, practitioners and managers both uniformed and civil, emerge and take on crucial assignments.

Organisationally, it was recommended that *Indu* would be an institution of national importance established by an act of Parliament with the president of India as visitor. In addition, a 15- member board of advisers would be appointed by the government to advise the head of *Indu* on matters relating to academic and research content and funding of programmes. *Indu* would be headed by presidents who would be serving three-star rank officers on a rotating basis. The acting president would come under the functional and administrative control of the chiefs of staff committee. The vice-president of *Indu* would be an officer of the Indian foreign service of the rank of additional secretary. The proposal clearly visualised the university to be run as an institution of the armed forces with academic, research and funding issues being overseen by the board.

Since it follows the broad model followed by the US National Defence University, members of *Condu* had comprehensive discussions with senior and retired civil and military leaders in the US to understand its logic and efficacy. Based on these, as well as further deliberations with various stakeholders in India, *Condu* was able to arrive unanimously at a model tailored to suit Indian security needs.

Recent reports indicate that there is now a deadlock between the defence ministry and the armed forces on who should head the proposed university. It would appear that the armed forces favour the model as proposed, whilst the ministry's viewpoint is that a prominent security expert with adequate administrative experience should hold the post. Since one is not privy to the detailed justification for the defence ministry's opposing viewpoint, one can only wonder why a university devoted to the study of military science should not be headed by a practitioner of military art when other national defence universities like those in the US, China, Pakistan, Poland, Finland and Malaysia are. One can only guess that beneath superficial arguments lies the perennial civil-military divide and a distrust of the uniformed fraternity.

Reports suggest that the defence minister, after having conferred with the three service chiefs, has referred the matter to the National Security Advisor (NSA) for resolution. Why an issue of importance to the national security of the country is being outsourced is anybody's guess. More so since the majority of students graduating from the university will be from the armed forces as also will be most of the institutions that will come under its ambit. Deeper ramifications underscore the rift between the civil and military which even the defence minister cannot remedy without arbitration.

One is not aware of what final shape the *Indu* proposal will take, considering that it has been subjected to a decade of incessant file-pushing through almost every corridor of the South and North Block. There is every likelihood that in the bargain much of the logic and spirit of the concept of *Indu* is now buried deep and the underlying spirit completely distorted.

There may, however, be a silver lining. The NSA is a highly regarded diplomat and deeply board and start its review, beginning with the fundamentals of the spirit and concept outlined in the Condu proposal. His having been the ambassador to China in 2001 while the Condu team visited Beijing would help as he had even made contributions to the deliberations then. And finally, bearing the heavy responsibility of the NSA's office he will understand the import of the wisdom of Sukraniti that "the strong control all and the weak have many enemies".

Air Marshal Brijesh D Jayal (retd.)

OPINION

Tactical nuclear weapons: a dangerous game

THE Pakistan Army's continuing efforts to arm the 60-km Hatf-9 (*Nasr*) short-range ballistic missile (SRBM) with nuclear warheads will adversely impact deterrence stability on the Indian subcontinent as tactical nuclear weapons are inherently destabilising and invariably escalatory. The *Nasr* missile was first tested in April 2011 and then again in May 2012 and is reported to be a replica of the Chinese M-20.

Even though 50,000 to 60,000 nuclear warheads were produced since the senseless bombing of Hiroshima and Nagasaki in 1945, some basic human survival instinct "repeatedly stayed the finger that might have pushed the button". The world's abhorrence for nuclear weapons is now so widespread and deep-rooted that even if battlefield or tactical nuclear weapons (TNWs) were to be used against a purely military target in a conflict in future, the effect would be strategic. In fact, the impact would be geo-strategic as the explosion of even a single nuclear weapon anywhere on earth would be one too many. The employment of nuclear weapons as useful weapons of war was always doubtful; it is even more questionable today. Given the widespread abhorrence of nuclear weapons, the Nuclear Rubicon cannot be lightly crossed now and whichever nation decides to cross it will have to bear the consequences.

According to William R. Van Cleave and S. T. Cohen, "… the term tactical nuclear weapons in the closest approximation refers to battlefield nuclear weapons, for battlefield use, and with deployment ranges and yields consistent with such use and confined essentially in each respect to the area of localised military operations." Some air-dropped nuclear glide bombs, carried by fighter-bombers, have been known to have yields of over one megaton. Parts of NATO's erstwhile TNW forces, including Pershing missiles, were on constant readiness alert as part of the Quick Reaction Alert force. The line dividing tactical (including theatre) and strategic nuclear weapons is rather blurred. While a strategic strike can be conducted with weapons of low yield, a tactical strike can be effected with virtually any class of nuclear weapons — though the results achieved may not be commensurate with the effort put in. For example, hitting a forward military airfield with an ICBM would be a gross overkill and would result in extremely high collateral damage. In fact, the phrase 'tactical use of nuclear weapons' would convey a more accurate sense of the intended use rather than 'use of tactical nuclear weapons'.

In the public perception, the most popular TNWs have been the 8-inch (203 mm) M-110 and the 155 mm M-109 atomic artillery weapons, and the *Lance* and *Honest John* SRBMs. At the upper end of the range scale were the *Pershing* missiles with a range of 160 to 835 km. These were intermediate range theatre SRBMs. The erstwhile Soviet and Warsaw Pact forces had their own corresponding TNWs. Among the better known ones were the FROG and *Scud* series of rockets and missiles. In addition, there was a category of weapons known as 'mini-nukes'. These had yields from 0.05 to 0.5 kilotons.

TNWs, particularly those of the US and its NATO allies, were nuclear warfighting weapons and formed an important part of NATO's strategy of flexible response or 'first use' policy. These weapons were among the first that would have been used in the early stages of a NATO-Warsaw Pact war.

During the Cold War, the proponents of TNWs justified their requirement on the following grounds: they deter the use of TNWs by the enemy; they provide flexible response over the whole range of possible military threats; they offer nuclear military options below the strategic level; they help to defeat large-scale conventional attacks; and they serve the political purpose of demonstrating commitment to the allies. The opponents of TNWs asserted that these 'more usable' weapons would lower the nuclear threshold and make nuclear use more likely. Fears of collateral damage in the extensively populated and developed NATO heartland spurred European opposition to TNWs. Many European political and military leaders convincingly argued that NATO would be better off without TNWs. Alain Enthoven wrote: "Tactical nuclear weapons cannot defend Western Europe; they can only destroy it… there is no such thing as tactical nuclear war in the sense of sustained, purposive military operations…"

There are other compelling reasons too for leaving TNWs out of the nuclear arsenal. Firstly, these are extremely complex weapons (particularly sub-kiloton mini-nukes, because of the precision required in engineering) and are difficult and expensive to manufacture and support technically. Inducting them into service even in small numbers would considerably raise the budget of the strategic forces. Secondly, the command and control of TNWs needs to be decentralised at some point during war to enable their timely employment. Extremely tight control would make their possession redundant and degrade their deterrence value. Decentralised control would run the risk of their premature and even unauthorised use — Kissinger's 'mad major syndrome'.

Thirdly, since the launchers must move frequently to avoid being targeted, dispersed storage and frequent transportation of TNWs under field conditions, increases the risk of accidents. Lastly, the employment of conventional artillery and air-to-ground precision weapons by the enemy may damage or destroy stored nuclear warheads.

India has correctly opted not to go down the TNW route, but Pakistan has chosen to acquire these dangerous weapons. According to Pakistani analysts, the Hatf-9 (*Nasr*) missile is their answer to India's Cold Start doctrine as the use of TNWs will stop India's armoured spearheads advancing into Pakistan on their tracks. They miss the centrality of India's 'no-first use' doctrine completely: even one nuclear strike — whether in India or against Indian forces — will invite 'massive punitive retaliation', which Pakistan can ill afford.

It is now universally accepted that nuclear weapons are political weapons and are not weapons of 'warfighting'. By extension, TNWs now have no role to play in combat. The international community must come together to stop Pakistan's dangerous quest to acquire these destabilising weapons.

Brig. Gurmeet Kanwal (retd.)

Lockheed martin

Rear Admiral Devinder Sudan, ACNS (Air) with the LCA Navy prototype and PS Subramaniam of ADA at Bangalore Airport

SYSTEMIC CHANGE

Admiral Arun Prakash, former CNS on what the armed forces expect from the DRDO

At the outset, I would state that there is a need to unequivocally highlight importance of the DRDO in the Navy's scheme of things, and our sense of pride in its achievements. What we are proudest of is the symbiotic relationship that has evolved between the two organisations at all levels. This relationship has not come about as a matter of chance, but is something that both the DRDO and the Navy leadership have consciously and assiduously cultivated and nurtured over the years.

The fact that three of the DRDO labs carry the suffix "Naval" is only an external manifestation of this. Within these labs, naval officers work alongside scientists on developing cutting edge technologies, which have resulted in world-class systems for use at sea.

Not only that, we have also developed a process and a tradition of "putting our money where our projects are." Witness the LCA (Navy) project into which we have so far invested nearly Rs 500 crores. A naval aeronautical engineer is serving with the DRDO in a key role in its development. I do not think that there can be better synergy than that, between two organisations.

Today, we actually have on our ships at sea, and on our aircraft and helicopters in the air many systems developed by DRDO and produced by our PSUs, which are of world class. Amongst these are sonars, both hull-mounted, variable-depth and towed array; radars, both shipborne and airborne; torpedoes; electronic warfare equipment including ESM, ECM and ECCM suites; missile and torpedo counter-measures, special alloys, hull protection systems, special paints and many other valuable operational innovations.

Much of what has been inducted is of excellent quality. There are some systems where, in spite of much labour and tremendous effort there

ALENIA

are performance shortfalls. But we gratefully acknowledge the labours of our scientists, and would like to move on. So I have said that we will induct such systems into service as Mark I. But then we will demand Mark II, and that must meet our full requirements. The TAL torpedo is one such example.

What of the future? The way we look at it, we are fully committed to self-reliance and that means that future of the Navy is inextricably linked with that of the DRDO. It is worth mentioning briefly the Navy's force planning philosophy, whose foundation and corner stone is *self-reliance*.

What does this mean for the Navy and DRDO? It means that we will build in India all the ships, submarines and if possible, aircraft and helicopters that we need. Our current capability in warship building has some lacunae, especially at the high-end. We need to address them at the earliest to attain self-sufficiency. For example we have started making shipbuilding steel, steam and diesel engines, gearboxes, power generation machinery, hydraulic, pneumatic, air conditioning systems and some weapons. But there is plenty more that goes inside these ships. What we need to concentrate on now are advanced weapons, sensors, combat management systems and of course our ambitious networking programmes.

We have also decided that any 'transfer of technology' that we contract for in future will certainly not be the CKD, SKD or 'screw-driver' type that we have received so far, with no value addition to either our scientists or our industry. It must involve joint development, collaborative production and the right to develop (and market) a Mark II product.

In this context, I must acknowledge with gratitude the foresight and vision shown by DRDO leadership in concluding the path-breaking tripartite collaboration with a foreign partner for the development of some advanced systems for our warships, which will be commissioned in the coming times. In this project, we are sharing the funding as well as manpower liabilities with the DRDO. We are confident that this project, which involves DRDO scientists, naval engineers and industry representatives, will render tremendous benefits to the DRDO, the industry and to the Indian Navy. It should become a template for the future.

There are many DRDO items which have exciting naval applications including fuel cells (for propulsion) and steel bulbars (for ship building). But it is sobering to know that India today is the largest arms importer in the world. While we will always need to import some hardware, we must together ensure that not only do we reduce our import dependence, but that we become exporters as well.

So, what does the Navy expect from DRDO, which is to say as to what will lead to better synergy with the Armed Forces?

Firstly, we see the DRDO as a "service provider" to the three Services. It must be stressed however that the research carried out by DRDO labs cannot be an end in itself. It needs to be sharply focused at meeting some national defence requirement, whether it is in a long or short time frame. The faster the labours of the scientists in the lab bring a tangible benefit to the combatant in the field, the higher DRDO's credibility will be.

An example from US operations in Iraq : they recorded that over 60 per cent of casualties were from Improvised Explosive Devices (IEDs), mainly on roads, just as it happens to us in J&K. The US DoD constituted the Joint lED Defeat Task Force and tasked the Defence Advanced Research Projects Agency (DARPA), to come up with solutions. Within a year, implementation of the measures evolved by the Task Force reduced US casualties from IEDs by 50 percent.

There would be many such examples within the Indian Armed Forces too, where we need scientific solutions for combat related problems. For example, if IN ships have to be deployed in low intensity conflict operations in our neighbourhood, the biggest threat to them today would be from suicide bombers in high speed boats. This is a problem worthy of the DRDO, but do they have the inclination to address it? We are trying to induct electrical propulsion and air independent propulsion into our ships and submarines. Is it on DRDO's priority list?

The LCA Navy prototype airborne at Bangalore

Secondly, it is possible that DRDO does not come to know about Service priorities and it is suggested that DRDO scientists visit field units of the three Services on a regular basis to see the environment we function in, the problems the Forces face, and how DRDO can be of help. In fact I would recommend that a certain percentage of scientists be recruited by the Armed Forces through the Short Service Commission route, and after five or seven years should transfer laterally to the DRDO.

Thirdly, frequent time and cost overruns of substantial proportions tend to erode credibility of the DRDO in the eyes of the Services, which seek operational effectiveness to counter immediate threats. The solution however, does not lie in perpetual and unfounded 'optimism'. We must not shy away from facing the harsh reality of slippages, which are inevitable in research work. "If you share your problems with us, the Services will not only understand your difficulties but also render necessary support." It is certainly worth considering collaborations and consultancies to overcome technological hurdles at an early stage of a project, which is languishing. A system of foreclosing projects, which do not fructify in a reasonable timeframe, should be strictly imposed.

Fourthly and increasingly, India is being asked for hardware from its maritime neighbours, but sadly, there is no ready response to make. DRDO and NHQ need to discuss, and put together a package of Indian-designed and produced items like sonars, radars, communication and EW equipment and weapons, which can be offered to friends and allies in our neighbourhood.

Fifthly, one of the biggest problems faced on ships is the eternal struggle between the laboratories and the production agencies, when a newly installed indigenous system malfunctions on a ship. I think that it would be well worth investing in a special test site perhaps even a research ship, where complete integration of a system be jointly undertaken as part of ToT between DRDO and the production agency before installing it on a ship.

And finally, an unsolicited suggestion : we know that winds of change are blowing in our country, and one day possibly DRDO may also be asked to reinvent itself. In anticipation, it would be prudent to study defence research organisations elsewhere.

Foredeck of INS Teg : weapons suite includes surface-to-air and surface-to-surface missile systems, 100 mm medium range gun, close-in weapon system, torpedo tubes and anti-submarine rockets. The BrahMos surface-to-surface missile system co-developed by DRDO, and arguably the world's only supersonic cruise missile capable of engaging targets at extended ranges, is the long range punch!

The DARPA (inventors of the Internet), owns neither scientists nor labs, but hires bright young people from industry to undertake research projects. In Israel, defence research has been merged with the production agencies and this synergy generates both speed and efficiency in successful materialisation of projects. In 2001, the British converted their Defence Evaluation & Research Agency (DERA) into a private-public enterprise and renamed it as QinetiQ.

Today the U.K.MoD holds 56 per cent shares in QinetiQ, which carries out research for the defence, security and commercial sectors and is a profit making company listed on the London Stock Exchange. Perhaps some similar systemic change may help re-energise and improve the performance of DRDO.

Once you begin to generate profits, you will be able to retain your young scientists.

[Extract from The Crow's Nest]

India and Russia in new defence contracts

The governments of India and Russia signed defence contracts worth $2.9 billion during the high level meeting between Prime Minister Manmohan Singh and President Vladimir Putin at New Delhi on 26 December 2012. These were formalised following the 13th annual India-Russia Summit during which the two leaders discussed the range of bilateral ties as well as global developments. The two new programmes were for 42 additional Su-30MKI combat aircraft that Hindustan Aeronautics Limited will produce at its facility under licence from Rosoboronexport and Sukhoi Corporation worth $1.6-billion plus a $1.3-billion contract for 71 more Mi-17V5 medium lift helicopters, of which 59 will go to the Indian Air Force and the balance 12 to the Border Security Force.

President Putin with Prime Minister Manmohan Singh at New Delhi

Rosoboronexport will deliver 'technical kits' to HAL to assemble the Su-30MKIs in India. "HAL's total responsibility for this supersonic multirole aircraft has now gone up to 222. We have already delivered 119 Su-30 aircraft to the IAF," HAL Chairman Dr RK Tyagi stated soon after the contract. "One hundred fifty seven Indian vendors are involved in providing 13,350 components of the aircraft while another 19,450 components are manufactured at HAL's Nasik and Koraput Divisions. The Su-30MKI project provides solid platform to indigenous manufacturing and technical competence creating hundreds of direct and indirect jobs", announced RK Tyagi.

S Subramanyan, HAL's Managing Director (MiG) signing the contract for Su-30MKIs with A A Mikheev, Deputy General Director of Rosobornexport. Dr RK Tyagi, Chairman, HAL is seen standing third from left.

Airbus A330 MRTT is IAF's future tanker

Airbus Military has been selected to supply six in-flight refuelling tankers to the Indian Air Force, with its A330 MRTT (Multi Role Tanker Transport) chosen instead of the Ilyushin Il-78MKI, six of which are already operated by the IAF and assigned to No. 78 Squadron.

The RFP for the new tankers was reissued in September 2010, nine months after a similar contract featuring the same competing aircraft was withdrawn. Commercial negotiations for the current contract will now begin and are expected to lead to final contract in the 2013-14 financial year.

The decision follows a lengthy selection process including the completion of extensive flight demonstrations in India by the A330 MRTT during which the aircraft refuelled multiple types of IAF fighters and operated from the high-altitude IAF base at Leh. Both aircraft passed technical trials, but the Airbus offer was adjudged "a superior commercial bid."

The IAF's requirement for mid-air tankers is urgent as it will be acquiring 200-300 new generation combat aircraft over the next decades. India's selection of the A330 MRTT makes it the fifth nation to commit to the type following Australia, Saudi Arabia, the United Arab Emirates and the UK, which have ordered a total of 28 aircraft.

First upgraded MiG-29s arrive

On 10 December 2012, Russia delivered the first three upgraded MiG-29 fighters to India, air transported on board an An-124 heavy lift aircraft. The modernisation programme is more than two years behind schedule, but will add greater prowess and versatility to the platform. Originally designed as an air superiority fighter, the upgraded MiG-29 UPG has been equipped

BERETTA

with new air-to-surface missiles, contemporary avionics, new radar, a glass cockpit, helmet-mounted displays and an inflight refuelling system. As per the contract, the aircraft's service life has been extended to 3,500 flight hours and 40 years.

Under a $ 900 + million contract signed in 2008, the Indian Air Force's fleet of 63 MiG-29s were subject of upgradation, the first six in Russia and the balance in India. First deliveries were originally scheduled for March 2010. RAC-MiG Director-General Sergei Korotkov said his company was making preparations for the second stage, "which involves modernisation of the fighters in India in close cooperation with Indian industry."

LCA in high altitude trials at Leh

Two Tejas LCAs (LSP-5 and -7) have been involved in extreme altitude and climatic (-20° C) trials from Leh (11,500 feet asl) during the second half of January 2013. The first such deployment of LCAs for high altitude/cold weather trials was in December 2008 when PV-3 and LSP-2 flew from Leh to validate various performance criteria, including avionics checks and assessment of engine performance. The team is led by JJ Jadhav, Programme Director LCA Mk.I and Commodore JA Maolankar of NFTC.

The combined fleet of LCA technology demonstrators, prototype vehicles and limited series production aircraft have accumulated over 1970 sorties till early January 2013 but, because of the three-month grounding in late 2012 owing to ejection seat issues, the initial operational clearance (IOC) is now likely to be achieved by July 2013. The first series production LCA is scheduled for delivery in September 2013. No.45 Squadron, which has been number plated for several years after flying the MiG-21M, has been earmarked as the first unit to receive the Tejas LCA Mk.I and after 'work up' at Bangalore, will move to Sulur, near Coimbatore.

MiG-29Ks on 'Admiral Gorshkov'

A series of test flights by MiG-29K/KUB fighters have been carried out by Russian test pilots from the carrier *Admiral Gorshkov,* before its commissioning as the INS *Vikramaditya*. Various technical systems, optical systems employed for landing, ski-ramp take off and various communication systems were assessed.

The INS *Vikramaditya* will deploy 16 MiG-29K/KUB fighters on board, with a total of 45 aircraft ordered by India in two batches. The Russian Navy has followed with a contract for 24 MiG-29K/KUBs to be delivered from 2015 to supplant the present Su-33 fighters on the *Admiral Kuznetsov*.

CCS clears Coastal Security Proposal

In mid-December 2012, the Cabinet Committee on Security (CCS) cleared a proposal for acquiring assets to enhanced coastal security. The CCS meeting, which was chaired by Prime Minister Manmohan Singh, cleared proposals worth Rs.2,150 crore under which five offshore patrol vessels would be procured for the Coast Guard (at Rs.1,500 crore) plus some Rs. 650 crore for setting up the second phase of coastal security network under which 38 radar stations would be established to create electronic surveillance along the entire coastal built.

Under the Coastal Security Network (CSN) phase-I, Defence Minister AK Antony had recently inaugurated coastal radars in Gujarat and Maharashtra. Another such radar has also started functioning in Kochi (Kerala). The Ministry hopes to complete the CSN phase-I by March 2013.

Brahmos

Hovercraft and interceptor boats for Coast Guard

On 12 December 2012, the Indian Coast Guard inducted a second in the series of Hovercraft (ICGS H-188), designed and built by Griffon Hoverworks Limited. This was formally commissioned at a ceremony in Haldia (West Bengal) by Inspector General Rajendra Singh, DDG of ICG. The first and third in the series, H-187 and H-189, were inducted in June and November 2012 at Okha in Gujarat under the administrative and operational control of the Commander Coast Guard Region (North-West). These are part of the 12 new Air Cushion Vehicles (ACVs), with 31-tonne displacement and achieving top speed of 45 knots. The ACV is capable of undertaking multifarious tasks such as surveillance, interdiction, search and rescue and rendering assistance to small boats/craft in distress at sea.

With the commissioning of H-188, the force level of ICG has gone up to 77 ships and boats and with the planned inductions, this would be doubled by 2018. The ACV induction is expected to be completed by June 2014.

Fifth Coast Guard regional Headquarters at Kolkata

On 10 December 2012 the fifth Coast Guard regional headquarters (North East) was inaugurated at Kolkata, West Bengal by Governor and former NSA MK Narayanan, as also the co-located Coast Guard Station.

The region itself has been carved out from the erstwhile Coast Guard Region (East) to strengthen coastal security and augment operations along the northern Bay of Bengal. The regional headquarters in Kolkata will exercise operational and administrative control over all Coast Guard assets in West Bengal and Odisha, with jurisdiction over 150,000 sq kms of the Indian Exclusive Economic Zone, extending up to the India-Bangladesh International Maritime Boundary Line. The region will be further strengthened with basing of additional ships and aircraft plus commissioning of two Coast Guard Stations, one each at Frazerganj and Gopalpur, and an Coast Guard Air Enclave at Bhubaneswar.

"Budget cut to affect IAF modernisation": ACM Browne

In a comment made on 7 January, Air Chief Marshal NAK Browne, stated that the decision to curtail the defence budget by Rs 10,000 crore will affect Air Force modernisation projects and that "the issue will be taken up with the government."

The Air Chief, on a visit to Phalodi Air Force Station near Jodhpur, told media persons that the IAF's on-going modernisation and expansion has been made possible "due to generous sanctioning of the budget by the government and its full utilisation". However, he said that the budget "curtailment will affect modernisation of the Air Force."

The government has imposed a cut of around five per cent in the Rs 1.93-lakh-crore defence budget in view of the present economic slowdown. This makes it likely that key projects such as procurement of 126 multi-role combat aircraft are likely to 'spill over'to the next fiscal year.

HAL to function as "lead integrator" for the MMRCA

Dassault is currently engaged in negotiations with the Indian Ministry of Defence, Air Force and HAL on the Rafale programme. The Ministry of Defence has clarified that Hindustan Aeronautics Ltd (HAL) will function as the lead integrator for production of the contracted 108 M-MRCAs in-country. This was in response to Dassault Aviation's public request that HAL's role in the programme "be clearly defined."

As per the RFP, the first 18 of 126 aircraft are to be supplied by Dassault from its facilities in France while the remaining 108 are to be licence produced and integrated by HAL at its facilities in Bangalore.

Dassault had reportedly requested such clarification from the MoD that, if it was given overall responsibility for the project, it should be given the freedom to decide the work share allocation between HAL and private companies. Shortly after Dassault was declared as 'L1' for the MMRCA programme, it had formalised an MoU with Reliance Industries Ltd (RIL) for participation in various aerospace projects.

India and Ukraine Defence Co-operation

On 10 December 2012, in presence of Prime Minister Manmohan Singh and Ukrainian President Viktor Yanukovych, the Governments of India and Ukraine signed a defence framework agreement. The most important programme between the two countries remains upgradation of the Indian Air Force's large fleet of Antonov An-32s at Kiev which began in 2009. Over 100 An-32 tactical transport aircraft serve with the IAF and the OEM in Ukraine have already upgraded some 25 of these with the rest to be worked on by No.1BRD at Chakeri in Kanpur.

Antonov An-32 of the IAF

The Indian Navy has also requested use of the shore-based take-off and landing facilities at Novofedorivka to train its naval pilots for operations from the aircraft carrier *Admiral Gorshkov*. This Ukrainian Air Force base is on the Black Sea coast of the Crimean Peninsula, north of Sevastopol. The simulated carrier take-off facility here has an arresting gear and ski-jump ramp which is a full-sized mockup of the aircraft carrier *Admiral Kuznetsov's* bow and continues to be leased by the Russian Navy.

First P-8I for Indian Navy

On 20 December 2012, Boeing officially delivered the first of eight P-8I long range maritime patrol and anti-submarine warfare aircraft on order for the Indian Navy at Seattle. To be operated by INAS 312 *Albatross* and based at INS *Rajali* at Arakkonam in Tamil Nadu, the P-8Is will enhance the Indian Navy's strategic reach capabilities, enabling 24x7 coverage of the IOR (see article *Lords of the Ocean* in *Vayu* VI/2012).

The eight Boeing P-8Is will replace Soviet-era Tupolev-142M

Three of the eight Boeing P-8I Poseidons on order for the Indian Navy at the Boeing Field in Seattle

Bear Foxtrots currently operating out of Arakkonam. Equipped with Harpoon Block II anti-ship missiles plus Raytheon Mk.54 Torpedoes, Mk.82 depth bombs and other weapons, the P-8I will be equipped with the Raytheon modified AN/APY-10 multi-mode radar mounted in the nose and supplemented with the Telephonics AN/APS-143Cv3 OceanEye radar for aft coverage.

INS 'Saryu' OPV for Indian Navy

On 22 December 2012, Goa Shipyard Limited (GSL) handed over INS *Saryu*, the largest offshore patrol vessel built for the Indian Navy. The indigenously-designed 105-metre vessel was handed over by GSL Chairman Rear Admiral (Retired) Vineet Bakhshi to Commander Amanpreet Singh, the Commanding Officer-designate of INS *Saryu*, in Goa.

INS Saryu

The offshore patrol vessel is to augment the Indian Navy's assets undertaking maritime surveillance and surface warfare operations "in order to prevent infiltration and transgression of maritime sovereignty."

Establishment of maintenance facilities for Hawk AJTs

"A total of 16 Hawks are AOG (aircraft on ground) as on date for want of spares (rotables). Affected spares have been dispatched to vendors (HAL and BAE) for repair," stated Defence Minister AK Antony in the Lok Sabha on 20 December 2012.

In 2004, the government of India had contracted with BAE Systems for 66 Hawks, the first 24 received as 'flyaway' from Britain, with the remaining 42 manufactured under licence from BAE by Hindustan Aeronautics Ltd (HAL) in Bangalore. Follow on orders have been placed for another 57 Hawk Mk.132s with another 20 likely to be ordered, primarily to re-equip the IAF's future formation aerobatic team. 17 of the Hawks would be for the Indian Navy.

IAF Hawk pair in formation take off

On the actions taken to ensure availability of the aircraft for pilot training, Antony said the government has initiated establishment of in-country repair and overall facilities at HAL, long-term product support agreement with BAE, procurement of spares from BAE and indigenisation of spares.

India, Russia to develop Air-Launched BrahMos

The governments of India and Russia have formalised an agreement to develop an air-launched version of the 290-km-range BrahMos supersonic cruise missile, which would be integrated with modified Su-30MKIs of the Indian Air Force.

The agreement was signed between BrahMos Aerospace, Russian Rosoboronexport and Sukhoi Design Bureau in December 2012, after several rounds of negotiations. Earlier, the Cabinet Committee on Security (CCS) had cleared the IAF's proposal worth over Rs 6,000 crore to buy BrahMos missiles for integration with Russian-origin Su-30MKI. As per plan, first test of the air-launched version of the supersonic cruise missile will be conducted in mid-2013, for which two Su-30MKIs of the IAF would be suitably modified.

Testing of Prithvi-II

On 21 December 2012, a Prithvi-2 nuclear-capable 350-km range ballistic missile was launched from the Integrated Test Range (ITR) at Chandipur-on-sea in Balasore district, around 230 km from Bhubaneshwar, in what is termed as a "user-trial".

"The mission was successful," ITR director MVKV Prasad said soon after the test, which had a flight duration of 483 seconds, the Prithvi reaching a peak altitude of 43.5 km. This training exercise by the Strategic Forces Command was monitored by Defence Research and Development Organisation scientists.

Russian Helicopters to establish assembly plant in India

Russian Helicopters, a subsidiary of Oboronprom (part of Russian Technologies State Corporation) and Elcom Systems Private Limited (part of the Indian investment conglomerate SUN Group) have signed an agreement to establish an industrial facility for manufacture of Kamov and Mil helicopter types in India.

It is reported that the enterprise will start with production of components for the Ka-226T light helicopter. According to Dmitry Petrov, CEO of Russian Helicopters, "the joint venture will help drive the development of India's aerospace industry and provide for effective application of advanced Russian technologies. It will also make it possible to organise the training of Indian engineers and promote the development of highly qualified personnel across the entire production chain"

IAI in MOU with BEL on LR-SAM

A memorandum of understanding (MOU) was signed on 5 December 2012 between Bharat Electronics Limited (BEL) and Israel Aerospace Industries Ltd. (IAI) for cooperation on the future LR-SAM ship-defence system projects. The signing ceremony was between IAI's President & CEO, Joseph Weiss, BEL's Director Marketing, HN Ramakrishna, Eli Alfassi, Corporate VP India Operations, and other representatives.

Joseph Weiss, President and CEO of IAI (right) with HN Ramakrishna, Director Marketing of BEL

The MoU lays out the framework for BEL-IAI cooperation, under which BEL will function as the lead integrator and produce major sub-systems. IAI will continue to act as design authority and produce sub-systems as a main sub-contractor of BEL.

Test launch of Agni-1

The Strategic Forces Command test launched the nuclear-capable Agni-1 ballistic missile off the coast of Odisha on 12 December 2012. The 12-metre-long missile can carry a one-tonne conventional or nuclear warhead. According to senior DRDO scientists, who supervised the operation, "the test was part of the Strategic Forces Command (SFC) personnel's regular user training. All the mission objectives were successfully met."

DRDO Astra test-fired

DRDO's Astra beyond-visual-range air-to-air missile (BVRAAM) was successfully test-fired from the ground in December 2012. The initial test launch on 21 December was carried out against an electronic target, although a Lakshya PTA was used to validate ground systems such as the radar.

The second test, conducted on 22 December, saw the Astra successfully intercept a Lakshya PTA. In its final form, the Astra will be able to engage targets beyond 100km from the launch platform, and is expected to be integrated with the Su-30MKI, MiG-29 and the Tejas LCA.

Indo-Russian co-operation in satellite navigation

The governments of India and Russia have signed a memorandum of understanding to cooperate in satellite navigation through the Russian constellation of satellites, *Glonass*, which is an alternative to the US-controlled Global Positioning System (GPS).

"Russia is key partner in our efforts to modernise our armed forces and enhance our defence preparedness. A number of joint design, development and production projects are underway in high technology areas," Dr Manmohan Singh stated after the summit meeting when also discussed was the imminent withdrawal of foreign troops from Afghanistan.

First AW 101 for VIP Comm Squadron

First of 12 AW 101 helicopters, which were contracted for in February 2010 at a value of Rs 3,546 crore, arrived at Palam in late December 2012, with the balance scheduled for delivery by July 2013. The three-engined, specially-configured helicopters will replace the ageing Russian-origin Mi-8s and Mi-17s with the IAF's Communication Squadron, and operated for VVIP flights. The IAF's AW-101 helicopters, eight in VVIP configuration and four for normal transportation are fitted with contemporary self-defence systems including missile-approach warners, chaff and flare dispensers and infra-red electronic countermeasures.

AW 101 in IAF colours during test flight in the UK

221 cadets commissioned into IAF

221 cadets, including 31 women, graduated from the Air Force Academy (AFA), Dundigal as commissioned officers during the Combined Graduation Parade held at AFA on 15 December 2012. Chief of Naval Staff, Admiral DK Joshi, took the salute at the parade. Cadets from different streams had earlier undergone basic training at various Air Force Training establishments such as the Air Force Administrative College, Coimbatore, Air Force Academy, Hyderabad, AFS Hakimpet, AFS Yelahanka and AFS Begumpet.

Newly commissioned women officers of the IAF

Amidst jubilation and celebration, relatives of the cadets watched as their wards were formally commissioned into the Indian Air Force. The traditional flypast by Hawks, An-32s, Dornier 228s and Kirans was followed with low-level aerobatics display by a Su-30MKI.

New Assault Rifles for the Indian Army

The Indian Army will replace its indigenous INSAS rifles, which have suffered from continued problems since their induction in 1994-95, with new-generation assault rifles having interchangeable barrels for conventional warfare and counter-insurgency ops. Indian troops are to be equipped with new close-quarter battle (CBQ) carbines, light machine guns (LMGs), specialised snipers and anti-material 'bunker-bursting' rifles.

According to reports, the COAS General Bikram Singh has identified acquisition of the new assault rifles for the Army's 356 infantry battalions and some other 'fighting and support arms' in the 1.13-million force as a 'Priority-I' project. Defence Minister AK Antony has confirmed that the project to replace the 5.56mm INSAS rifles was underway since 'technological developments have created more superior rifles over the years'.

Likely contenders for the programme include Colt, Beretta, Sig Sauer, Ceska and Israel Weapon Industries (IWI), and the selected entity will partner with the Ordnance Factory Board (OFB) in the project. Initially 65,000 rifles will be procured directly from the selected foreign vendor for an estimated Rs 4,850 crore, to equip 120 infantry battalions deployed on the western and eastern fronts. The OFB will subsequently produce over 113,000 rifles under transfer of technology. The requirement could well grow if the paramilitary forces (with 800,000 strength) also induct these rifles.

According to a defence ministry source, "Technical evaluation of bids submitted by the five firms is over. The field evaluation trials will begin in early-2013. The plan is to begin inducting the new rifles by mid-2014.'' The process for LMGs and bipod sniper rifles will follow soon. The Army wants over 16,000 LMGs and 3,500 sniper rifles, both with an effective 1-km range, for its infantry battalions to begin with.

ASEAN countries laud India's 'Look East' Policy

With India and ASEAN agreeing to elevate their relations to a strategic partnership, Vietnam has requested India's "support" in the "full implementation" of the code of conduct in the South China Sea. On 20 December 2012, at the Indo-ASEAN Commemorative Summit in New Delhi, Vietnamese Prime Minister Nguyen Tan Dung said "I hope India supports ASEAN in the full implementation of the declaration on the conduct of parties in the South China Sea and the six-point principle on South China Sea in order to settle disputes peacefully as per international law".

However, apart fromVietnam, none of the 10 members of ASEAN mentioned China by name but instead focused on strengthening cooperation on maritime security. "We are committed to strengthening cooperation to ensure maritime security and freedom of navigation and safety of sea lanes of communication for unfettered movement of trade in accordance with international law".

India has meanwhile, become the fourth country, after China, Japan and South Korea, to enter into a strategic partnership with

ASEAN. "I am very happy that we have decided to elevate our relationship to a strategic partnership. This is a historic step, and together with the conclusion of negotiations on free trade agreement in services and investments, defines a qualitatively new paradigm of our partnership. It is a natural progression of the journey we embarked on together in 1992 and it will serve our relationship well in the next decade and beyond," Dr Manmohan Singh said.

The Philippines too has hailed the underlying sentiment as part of India's 'Look East' policy. Vice President of the Philippines, Jejomar Cabauatan Binay stated that "in the present day, these issues are no longer of parochial interest. Freedom of navigation and lawful commerce are universal interests. The statement (of the Indian Navy Chief) is confirmation that it is a problem that India cannot turn its back to." Making a big pitch for increased Indian investment in the Philippines, he added, "we look forward to Indian investment, tourism and culture. We also welcome Indian pharmaceuticals into the Philippines, because India is very advanced in this sector. But more than that, we want to have a deeper political and security relationship with India."

COAS visits Sri Lanka

General Bikram Singh, Chief of Army Staff visited Sri Lanka 19-22 December 2012 on a four-day visit to strengthen

bilateral military ties. Apart from top political and defence officials, the COAS also met Sri Lankan President Mahinda Rajapaksa during his four-day visit. He also reviewed the Passing Out Parade at a Military Training Academy in the central resort of Diyatalawa.

According to analysts, the Indian government is trying to balance larger strategic considerations in the backdrop of China making steady inroads into Sri Lanka, and domestic political considerations. Early in 2012, the UPA-II government had been forced to shift 27 Sri Lankan Air Force personnel being trained at Tambaram near Chennai to Yelahanka near Bangalore after political parties in Tamil Nadu had raised "objections."

Although the Indian Government has cleared military training to personnel from several other countries, including the Maldives, Mauritius, Mongolia, Botswana, Uzbekistan, Tajikistan and significantly Afghanistan, the facilities extended to Sri Lanka are broad based, with around 800 to 900 Sri Lankan military personnel trained at different Indian military establishments every year.

India enhances military ties with Myanmar

As part of new initiative, an Indian defence delegation led by Air Chief Marshal NAK Browne undertook a four-day visit to Burma 26-29 November 2012, meeting President Thein Sein, who was accompanied by high-level military chiefs Vice Snr-Gen Min Aung Hlang (the commander-in-chief of Burma's Defence Services) and Gen Myat Hein (Commander-in-Chief of the Air Force). The Air Chief Marshal "discussed a wide range of bilateral issues on ongoing defence cooperation between the two countries, and further outlined areas of mutual interest as part of a broader military engagement." The Indian delegation also visited Burma's National Defence College and key military establishments, where they were briefed by the Ministries of Foreign Affairs and Home Affairs.

IAF Chief and Chairman Chiefs of Staff Committee, Air Chief Marshal NAK Browne calls on the President of Myanmar, U Thien Sein, in Myanmar on 27 November 2012.

This high-level defence visit came close on the heels of Burmese opposition leader Aung San Suu Kyi's six-day trip to India in November, and the Indian Prime Minister Dr Manmohan Singh's visit to Burma in May 2012.

India had earlier sought Myanmarese junta's cooperation in flushing out Indian insurgent groups operating from Myanmarese soil as well as to bolster its eastern region's connectivity to the outside world. India has transferred certain defence equipment including Islander maritime patrol aircraft as well as 105mm light artillery guns, naval gun boats, mortars, grenade-launchers and rifles to Myanmar, the only ASEAN country with which it shares land and maritime borders.

Asbestos aboard INS 'Vikramaditya'

Even as the delivery of India's second aircraft carrier, INS *Vikramaditya,* has been pushed back towards the end of 2013 owing to the malfunctioning boiler section, activists and environmental advocacy groups have expressed concern over reported use of asbestos-based insulation in the warship. Asbestos is a silicate material that is a known carcinogen. Given the health hazards that asbestos poses and the fact that International Maritime Organisation (IMO), of which India is a member state since 1959, has banned installation of all types of asbestos-containing materials as of 1 January 2011, activists have expressed "shock and surprise" over India's willingness to accept use of asbestos in the aircraft carrier's insulation in the boiler section.

Responding to a query on repeated delays in delivery of INS *Vikramaditya*, CNS Admiral Joshi said that the decision had been taken by contractors who were refitting the warship in Russia. "The insulation inside the boilers had become misplaced. Initially, it (the insulation) had been kept asbestos free, which was a contractual stipulation. We had nothing to do with that decision. It was an internal decision of the supplier," the Navy Chief said. Admiral Joshi also said that the boiler would be a sealed unit and the environmental degradation factor externally "would be negligible."

Delays in R&S helicopter procurement

In view of further delays in meeting the requirement for 197 light reconnaissance and surveillance helicopters for the Indian Army and Air Force, the MoD has asked Eurocopter and Russia's Kamov to extend the validity of their commercial bids. The field evaluation trials for the Eurocopter AS 550 C3 and Kamov's Ka-226T had been concluded at the end of 2010 but after the MoD received several representations about "technical deficiencies", it set up a technical committee to examine the matter. The committee reportedly cleared the helicopters in December 2011 but put the onus on the MoD to waive off certain deviations from the required specifications in both contenders. However, a year on, the MoD has still not taken a decision and requested the manufacturers to extend the bids for another year.

AS 550 C3 Fennec

Kamov Ka-226T

The programme has been delayed by almost a decade, as the earlier evaluation was "won" by Eurocopter in 2007 but cancelled following allegations of technical irregularities. According to current reports, Eurocopter has informed the MoD that they would be unable to grant a further extension to their commercial offer "in absence of any visibility regarding finalisation of the case."

Army to receive 22 Cheetal Helicopters

Owing to continued delays in replacing its ageing Cheetah/ Chetak helicopters, the Defence Ministry has cleared procurement of 22 HAL Cheetal helicopters for the Indian Army for operations in Ladakh and other high altitude areas. The Cheetal is a re-engined Cheetah (with the TM 333-2M2) manufactured by HAL at its Helicopter Complex in Bangalore.

The European Eurocopter AS 550 C3 and Russian Kamov Ka-226T Sergei are in competition to supply these new helicopters but the MoD is yet to take a final decision on starting commercial negotiations with the two OEMs. The Navy has also issued an RFP for procuring 56 naval utility helicopters to replace its fleet of HAL Chetak helicopters.

HAL Lancer (based on the Cheetah) at high altitude in the Himalayas

IN seeks medium-range ASMs

In December 2012, the Indian Navy issued an RFI regarding the acquisition of an unspecified number of medium range anti-ship missiles. The missiles are intended to be integrated on new as well as existing surface ships "and must have a range of 120 km or more." On the performance front, the RFI document indicates that the requirement is for a high-subsonic (at least M0.9), sea-skimming (5 to 20 m above sea level) missile, with a warhead weighing at least 100kg and total missile weight not exceeding 1000kg.

Harpoon missile being launched from guided missile cruiser USS Lake Erie

Contemporary products that fit these specifications include the Boeing RGM-84 Harpoon, Saab RBS-15, Zvezda Kh-35 and MBDA Exocet.

Army's permanent aviation cadre

Following the government's announcement that the Army will operate all future attack helicopters, COAS General Bikram Singh has approved the establishment of a permanent Army Aviation Corps (AAC) cadre. The AAC already operates some 250 light helicopters such as the HAL Dhruv, Cheetah and Chetak and short-term plans are to add light observation helicopters and attack rotorcraft to this force. In the long term, the army envisages using medium-lift helicopters and fixed wing light transport aircraft.

At present, the AAC has 'seconded' cadre of approximately 10,000 personnel with a further 5,000 on deputation from other branches of the Army. The new plans would have these 5,000 additional personnel given the option to stay on as permanent members of the AAC, as well as conduct fresh recruitment.

Spearheading this expansion drive, induction of the first squadron of HAL *Rudra* (armed variant of the Dhruv ALH) into the AAC is scheduled for March 2013. This armed and lightly armoured helicopter can fly higher than the IAF's present attack helicopter type, the Mi-35, which is a crucial requirement for the Army's high-altitude mountain operations.

HAL's Rudra ALH-WSI

These announcements come shortly after the MoD confirmed that the most recent attack helicopter acquisition – 22 Boeing AH-64 Apache helicopters – would go to the Air Force, with all subsequent attack rotorcraft to be procured by the Army. Despite protests regarding "duplication of efforts" by the IAF, this move is intended to allow the Army to utilise air power for 'tactical' tasks on the battlefield whilst the IAF handles the 'strategic' aspects of aerial warfare.

Major IAF exercises in 2013

The Indian Air Force will take part in three major training exercises in the first half of this year, including the IAF's participation in the *Red Flag* wargames held periodically at Nellis Air Force Base in the US state of Nevada, five years after their first appearance in 2008. This year will see significant non-NATO participation at *Red Flag*, with Sweden joining the exercise this time.

Su-30MKI with Jaguars in exercise.

In late February the IAF will conduct a massive armament exercise at the Pokhran ranges called *Iron Fist* (previously *Vayu Shakti*). The programme will include day and night operations and will also mark first time the Tejas LCA will participate in an IAF exercise with live weaponry. A pre-firing demonstration and

dress rehearsal for the exercise was conducted in late December 2012 when some 100 different types, including the Su-30MKI, Mirage 2000, Jaguar, MiG-21, attack helicopters, UAVs and AEW&C aircraft took part.

In March, the Air Force will conduct the largest and most comprehensive exercise in its history. Called *Live Wire,* this will involve all commands and test integrated, joint operations. With this exercise, the IAF aims to "validate battlefield preparedness and tactics surrounding the use of newly acquired assets such as in-flight refuelling and AEW&C aircraft."

Army exercises 'cold start' doctrine

Until recent years, quick and effective mobilisation had never been the Army's forte. This was most painfully obvious during *Operation Parakram,* the glacially slow deployment in response to the 2001 terrorist attack on Parliament. Since then, however, the 'cold start' doctrine has been developed and over the past decade the Army has built capabilities with a focus on capable, rapid deployments. This has included the building of better infrastructure in remote mountain regions and a greater emphasis on motorised assets such as tanks and ICVs, as well as more effective use of aerial assets.

A decade after *Parakram,* the Army conducted *Exercise Sudarshan Shakti* in 2011, validating its ability to "deploy quickly and in close concert with the IAF."

Helicopter Complex at Phalodi

On 7 January, Air Chief Marshal NAK Browne, inaugurated a new Medium Lift Helicopter (MLH) Complex and the raising of a new Mi-17V5 helicopter unit at Phalodi in Rajasthan. Inauguration of these pre-engineered hangars, the biggest of their type in the IAF, would add to the operational capabilities of this new air base. The base, including the new facilities, will be utilised during upcoming IAF exercises : *Iron Fist* on 22 February 2013 and *Live Wire* in March 2013.

The Air Chief was received by Air Marshal AK Gogoi, AOC-in-C, South Western Air Command and Group Captain Prashanth Mohan, Station Commander, AFS Phalodi. After the inauguration, the CAS also addressed the Station personnel and emphasised on operational importance of the Station.

During his two-day visit to the Rajasthan-Gujarat sector, Air Chief Marshal NAK Browne flew a Jaguar aircraft of No.16 Squadron based at Bhuj air base. He had commanded No. 16 Squadron, 'Cobras', from 1990 to 1992 and is now the Squadron's Commodore Commandant. This was ACM Browne's first visit to Bhuj since taking over as the Air Chief in 2011.

ABG Shipyard wins contract

ABG Shipyard Limited, the country's largest private ship building company has received a repeat order worth about Rs. 485 crore from the Ministry of Defence for building an additional cadet training vessel for the Indian Navy. The vessel will be approximately 110 metres in length with the capacity to carry a light helicopter. Designed to achieve a maximum speed of 20 knots, the vessel will be used to provide basic training to Naval Cadets and trainees in activities such as disaster relief, search and rescue operations.

The Shipyard has so far built and delivered more than 160 ships, of different specifications for domestic and international customers, and is listed in position 61 among world 's shipyards (as per *worldyards.com*). ABG Shipyard's client base extends to Europe, South East Asia and the Middle East, with over 90% of its existing Order Book comprising export orders.

Bell Helicopter agreement with Dynamatic Technologies Limited

Bell Helicopter, a Textron Inc. company has signed a Memorandum of Understanding (MOU) with Dynamatic Technologies Limited (DTL) of Bangalore, India to explore establishing DTL as a subcontractor for its Bell 407 airframe cabin assembly, airframe components and details.

The estimated business volume of the work proposed is approximately $243 million over a ten year period starting in 2013. "Bell Helicopter is very pleased to continue to invest in India," said Rishi Malhotra, Bell Helicopter's general manager in India. "This is an important step forward in expanding our customer service, engineering and manufacturing capabilities in India."

India's "dismal domestic air travel market"

According to the International Air Transport Association (IATA), from being one of the fastest growing aviation markets in the world, India is now the "worst performing" domestic air traffic country globally. A 12.4% plunge in domestic air travel in October 2012 from a year ago is the "highest fall anywhere" and is being viewed as a reflection of "the weakening economy and struggles" within the domestic airline industry. "Weakness in India, Japan and the US, stands in stark contrast to the strong growth experienced in China and Brazil ," according to IATA's report on global traffic results.

"Unless the government does something fast on rationalising jet fuel prices, lowering landing and parking charges and steep airport user fees on passengers, especially in Delhi, the cost of flying would get prohibitively high." Domestic air travel in November 2012 had fallen by 15.7% over the same month last year.

According to a senior official, the operating cost for an airline in India is among the highest in the world. High prices of jet fuel—caused by a high base price set by oil PSUs and then the 20-40% sales tax levied by states on that high base – along with steep private airport user charges in Delhi are the biggest threat to airlines' survival. Other BRIC partners are leaving India far behind in the field of aviation. IATA records that Brazil experienced the strongest growth at 9.8% in domestic air travel in October 2012.

SpiceJet fleet increases to 51 aircraft

In December 2012, SpiceJet took delivery of the last 3 of 15 Q400 NextGen turboprop aircraft ordered from Bombardier, completing its short haul fleet, which is focused on enhancing air connectivity to Tier-II and Tier-III cities. This takes the airline's total fleet size to 51 aircraft. All the delivered 15 Q-400 aircraft were financed by the EDC (Export Credit of Canada) facility, agreed in June 2011.

Over the past 26 months (October 2010 to December 2012), SpiceJet has registered impressive growth, the fleet size increasing from 22 aircraft to 51, adding 14 Boeing 737s and 15 Bombardier Q400 aircraft during this period. The number of flights per day in the same period showed a 111% growth.

KFA revival plan with DGCA

Kingfisher Airlines, whose flying permit expired on 31 December 2012, has submitted a comprehensive plan regarding its revival to the DGCA. While details of the plan have not been confirmed by either Kingfisher or DGCA, it is believed that internal resources will be used to infuse cash into the debt-ridden airline. With a debt of nearly Rs. 8,000 crore, Kingfisher has been grounded since October 2012, following a strike by engineers and pilots who claimed they had yet to be paid the salaries due them. In fresh trouble for the airline, multiple lessors and financiers have filed suits or

are pressuring the carrier to return aircraft that were grounded. Chief among these is German bank DVB SE, which has filed a writ petition against Kingfisher and DGCA in Delhi to urge for deregistration of a number of grounded Airbus A320s so that they may be put to use elsewhere. To complicate matters between the lenders and the airline, many of these aircraft have been impounded as creditors scramble for assets with which they can recover money.

Which Service gets the Apaches ?

With obvious reference to reports that the Indian Army is seeking control of all attack helicopter assets, the CAS Air Chief Marshal NAK Browne has announced that the Apache attack helicopters, under contract with Boeing, would remain with the IAF as it was "an ongoing acquisition". The CAS added that the Apaches were not just for the anti-armour role or for air-to-ground operations but would be deployed for multiple tasks such as targeting enemy radar stations and interception of UAVs.

Defence Minister AK Antony had in October 2012 formally approved the long-stated demand by the Army for attack helicopters, overruling continued opposition from the Air Force, that all "future" procurements of such helicopters would be for the Army. However, ownership of this batch of Apaches remains an ambiguous matter.

IAF's Rafale requirement

According to Indian Foreign Minister Salman Khurshid, visiting Paris in mid-January 2013, the Indian Air Force order for Dassault Rafale MMRCAs could be enhanced to 189 aircraft. "There is an option for procurement of an additional 63 aircraft subsequently for which a separate contract would need to be signed" . The original RFP is for 126 aircraft and there is an option close for increasing this number by 50%.

"Bigger Challenges Await Us"

The Air Chief's New Year Message

Commending the Indian Air Force's men and women for their calibre, competence and professional commitment and wishing them continued success in all their endeavours, Air Chief Marshal NAK Browne, said that "the year gone by has been busy as also challenging; we faced many new challenges and we also achieved significant milestones. While these challenges tested our collective competence and resolve on one hand, they also served to reinforce our commitment and sense of pride in the values which the IAF represents. Despite facing various operational and maintenance challenges associated with the transformation phase, we continued to maintain a high combat potential."

"Our air warriors always remained at the forefront of all important nation building tasks be it executing humanitarian assistance and disaster relief operations, supporting anti-naxal operations or while providing aid to civil authorities by undertaking support missions in the remote and inaccessible regions of our country. In addition, we have also put into place many new initiatives in the areas of infrastructure upgradation, training, empowerment of our air warriors and institution of a Directorate of Air Veterans, which will have long term implications for the IAF. Looking back today, we can justifiably take pride in our collective achievements and contribution towards the growth of IAF."

"I strongly believe that more than any of the high technology acquisitions in the future, our air warriors would be the real enablers of our growth story. Irrespective of the position in which you may be presently serving in, I expect you to provide quality leadership to your subordinates. Invest your time in mentoring, guiding and training, and work towards creating an environment where each and every air warrior feels as a valuable member of the Indian Air Force family."

"Bigger challenges await us as we step into the New Year; challenges that will stretch our physical and mental capabilities. The timely integration of the new inductions with the existing legacy systems, while ensuring a high combat potential and addressing all aerospace safety concerns will be our key operational challenges. Towards this, Exercises *Iron Fist* and *Live Wire* are planned early this year. We must capitalise on this opportunity for revalidating and fine-tuning our operational employment philosophies in a near real-time op scenario."

"I am aware of the enormity of the task which lies ahead of us but at the same time, I am also confident about the collective resolve and competence of my team. As long as we can anchor all our actions to our core values of Mission-Integrity-Excellence and work with pride, we will always achieve our mission."

The CAS inspects the parade.

Rafael

The IAF at 80

MiG-21 bison

Mi-35

A relatively simple celebration of the Indian Air Force's 80th anniversary took place on 8 October 2012, at Hindon Air Force Station, near Ghaziabad on the outskirts of Delhi. The *Surya Kiran* Aerobatic Team was not there, their Kirans being sent to maximise training hours on ageing HAL HJT-16 Kiran trainer aircraft, which are nearing the end of their service lives, while the Dhruv helicopters were undergoing safety modifications at HAL, putting the Sarang display team out of view as well.

The IAF has begun the process of raising a new aerobatic display team with Hawk advanced jet trainer aircraft and a

Mi-17V5

Hawk Mk.132

March past a Su-30MKI

C-130J-30 flanked by An-32s

Marshal of the Air Force Arjan Singh DFC

request for proposal (RFP) has already been issued to British firm BAE Systems for supplying 20 new aircraft for the purpose. It is unclear whether the new team would retain the *Surya Kiran* name or be given a new one.

Airborne displays were limited to flypasts by various transport aircraft, including the IAF's newest C-130J Super Hercules An-32s, Dornier 228s, Avro 748s and combat aircraft such as MiG-21s, MiG-29s, Mirage 2000s, Jaguars, and Sukhoi Su-30MKIs. Rotary-wing assets were also on display, represented by Mil Mi-17V5s and Mi-35 attack helicopters.

Notable was the flying display of newly restored de Havilland DH 82 Tiger Moth biplane of the IAF's Vintage Flight Squadron based at AFS Palam. The IAF is planning to resurrect six historic aircraft types for the vintage squadron that will include, among others, a Wapiti, Harvard and Spitfire VIII.

The recently-delivered indigenous Airborne Early Warning and Control Aircraft (AEW&C), featuring a DRDO AESA radar and avionics suite mated to an Embraer ERJ 145 aircraft was on display on the ground, along with a C-130J, Mirage 2000, Su-30MKI, Jaguar, MiG-21, MiG-29 and Mi-17V5.

Tiger Moth of the IAF's Vintage Flight

EMB-145 AEW&C aircraft.

30 Years after the LCA's launch

A Change of Tack

The LCA programme has generated much debate about its outcomes. The fact that thirty years since launch of the programme, there is acrimony and debate would indicate that perhaps the programme has not quite gone the way it was hoped. Definitely there was much that could have been avoided. The entrusting of a crucial weapons-system replacement programme to an yet-to-exist agency was asking for trouble. This however is not the theme of the present review. The LCA programme relied on the hypothesis that if we caught up with the current technologies, we would be self reliant in military aviation. The antithesis would be : should we have focussed on creating *people* rather than *technology*? This needs debate because we shall have more programmes and as Einstein so famously said, "It is stupidity to repeat the same things and expect different results".

The 'essential technology' approach has long ago reached the point of diminishing returns and probably never made sense anyway. It is more the result of commercial manipulations. Seasoned aviation analysts talk of many expensive technologies that turned out to be almost fraudulent in their claims. Perhaps the more important point is that much of the advertised technical advantage, gained through much honest labour, could be "trumped" by something cheaper and more innovative. Lee Begin's team of Northrop NF/156/T-38-F-5/F-20 did brilliant work on the very important area of transonic manoeuvrability. The LEX and high AOA became fashionable with the F-5E/F-17. The advantages of all this work was rather neatly, if not trumped, at least much reduced by the HMS and cue-able IR seeker. The point to ponder is whether we should go for catching up on 'technology' as we seem to be doing, or should we go for developing people who can surely deliver what is wanted. This needs serious debate because perhaps for India it is a little too late for "catching up" and we are important enough as a nation to have our own view of things. Lending relevance to this debate is that there could be a change in the wind.

Change in the Wind?

Such change will come because in the decades ahead, the West may fail in arms exports. In the nineteenth century, it was Northern Germany that was in the decades ahead, centre of the wool trade. Successive generation of finer and finer wool breeding led to wool so fine that they began breaking in the looms. The less crimped Australian wool took over. The F-35/F-22 is irrelevant by being "too fine". The F-35 would perhaps have worried the Russians sleepless but cause no concern to the Afghans and other assorted militias. For the West it is not enough to produce a successful military aeroplane. It must produce the *commercially successful* military aeroplane. The English Electric Lightning was the last British fighter because it failed to sell. The F-35 is there because the F-15 made the money. The mediocre Starfighter, sold in thousands to NATO without any major US buying, shows how important the commerce is and how hard the 'sell'. Failures in terms of technology, time, cost,

numbers or combinations thereof in the B.787, A.380, F-22 or F-35 are probable and could devastate. The DC-10 showed how slender can the margin be between success and failure. It was a good and well designed aircraft. However failure to anticipate lapses in *field maintenance* practices led to two accidents and broke the back of Douglas, a repeat of De Havilland's Comet. Failure of the F-22/F-35 to achieve break even could change the entire approach to fighter specifications. If the F-22/-35 indeed fails, the funds will just not be available to develop thought-controlled FBW via electrodes planted in the pilot's brain which will have certain doubtful advantages ? It is also bemusing to ponder, despite impressive 'life cycle cost' analyses, as to what will happen to the present crop of large stealth fighters when they are past their prime? Will we be able to use them for close support duties as happens to all obsolescing fighters? That is not very likely. Is it possible that cheap "stealth–stripping" technology will make all these "wonder buses" look a bit silly ? We may see a swing not to higher technology fighters, and damn the consequent size, but to a line of thought which will be "what is the best we can do with an airframe no bigger than this", at least as a major supplement to 'shock and awe' brigade. In that emerging scenario India may have a role to play - if we decide to think our own way.

Sinking a groove in the paper

That "India can do it" has been repeated so often it has probably sunk a groove in the paper it has been printed on ! The unsung ALH is an example. This was a project with its own share of advanced technologies – glass cockpit, hingeless rotors and composites. It had its share of serious specification changes including a change from single to twin engines fairly late in the game. It had its share failures and delays and suffered from lack of funding and embargos and yet the product was ready, an acceptable performer with some truly record breaking feats and with over a hundred *in service* and a modest beginning in exports. There are now a stream of derivatives coming out. It is the classic picture of a successful project competently and *quietly*, one may add, handled by professional engineers who had grown up in the bran tub of Indian aviation. One wishes some of its project contemporaries were similarly handled. The point, and we will return to it, is that all this was achieved by men who were amongst the poorest paid of the state sector employees, who worked a six day 48-hour week and retired without even a pension. Though no supersonics are involved, helicopters can be nasty things to design. Weight is always a problem.

ALHs of the Sarang formation display team

The vibrations can cause sleepless nights and air conditioning a helicopter is like air conditioning a glass house. Weapons firing is like Errol Flynn shooting whilst swinging from a chandelier.

The fact is, in aviation, even 'simple' things can have all the elements of a detective novel. The HPT-32's persistent engine problem is another example. HAL has 'struggled' for twenty years to solve the problem. Let me put a 'teaser". I have absolutely no inside information but it is quite possible the HPT-32 engine failures are not due to the engine installation and fuel feed at all. The aeroplane needs a strong drag improvement programme including a new smaller fin–yes I know spin recovery was a problem but this can be tackled by other aerodynamic means. Or else a change of base from Bidar to Tambaram. Interesting? Ask me 'why' after you ask me 'what's yours?'!

Starting at external shadows

It is heartening to note that the arms dealer or 'agent' has usually not succeeded when a home grown product of acceptable quality was available. One mentions this because it has become automatic to accuse anyone demanding better accountability of failures as somehow being in foreign pay. In fact the problem is that the vectors for local development and the import lobby are evenly matched and resulting in a stalemate. A small change in the performance of one can make a big difference in the other. Usually it is the decision making technostructure, not the arms dealers, that have *allowed* more damage. The Canadians have not forgotten abandonment of the Avro Arrow and the English restrain themselves when talking of the TSR-2 where Whitehall and Labour allegedly "let the side down".

The Australian Victa, a superb trainer, lost when Australian legislations made imports even cheaper. The dealer succeeds through *administrative* deficiencies. The same goes about strident claims of how the customer services are 'uncooperative". It is not their job to be 'cooperative' and 1962 should have taught us that. The problem with accepting the Arjun MBT wholeheartedly may lie in the fact that the tank is excellent but the entire logistics, of bridging equipment *et al* who is right? The Air Force is damned for being 'finicky'. Had the Navy faced a situation where there was a possibility of losing a frigate with all hands due to half-baked equipment, they would bring back keel hauling. The actual situation is reasonable. Though there is absolutely no truth in the rumour that the first test on a new howitzer is to throw it off a thirty foot cliff, the Services, who allegedly even break wind by numbers (!) have well

HAL Cheetah in Ladakh

Arjun MBT on parade

may make offensive operation difficult to integrate. Could a lighter tank-an improved Tank X for example a la Centurion to Vijayanta, which were supposed to have many common systems - be quickly cobbled together or should we keep arguing about tried procedures for everything including induction. This is why we have always inducted fairly good equipment. This cannot be changed. That the customer has a stake in getting the deal through has to be accepted. The induction of the Insas, the Arjun, the Pinaka, the 'unrequited' wait for the Trishul and wait for the Akash and, significantly, the IOC-1 of the LCA Mk1 whilst being badly overweight and a decade overtime is a good indication of just how far the Armed Forces will bend over backwards to accept something - if it has the least bit of promise. The benefits of having a local supply chain is clear as daylight to any serviceman. The supremacy of the customer as a reason for existence of the supplier is taken for granted in the private sector. However, one suspects, in the government everyone remembers those recommendations of the last Pay Commission and where exactly the 'other' is ranked.

Higher pay is *not* the answer

Improving pay packets is 'knee jerk' reaction. The issue is not of salary as of the perceived *fairness*. Without a 'weeding' out or sidelining of non performers the benefits of any increase in pay packets is counter productive as it rewards the non–performer by paying him more for continuing not to perform. When the SA-6 missile programme had failures, the Head, the very respected (the design bureau was much later named after him) Tikhomirov, was replaced after *just three years*, since it was felt that the 'trot' rate of the project was not good enough. Let us not say that the USSR was knee deep with people of the capabilities of Tikhomirov. In India we have nurtured failures. A secure tenure encourages bias in assessment based on interpersonal rather than net worth. In the private sector, bias in evaluation can be present but to a significantly lesser degree is owed to an all round lack of 'security' and shareholder pressure.

A Division of the Tasks

It is difficult to get good designers. It is difficult to get good managers. It is impossible to get both in one person because the passion, focus, and time devoted for knowledge acquisition required for the one contradicts the other. The great engineers - Platz, Messerschmitt, Camm, Petter, Castoldi, Wallis *et al* - varied in temperament from polite stubbornness to geniuses just this side of barking mad. It was the task that 'blinkered' them so. They delivered because they were backed by an excellent management team who did the 'staff work'. The initial rapid progress of the HJT-36 prototype was owed to the fact

that the able chief designer (who was a quiet type!) was backed by a seasoned and extremely capable management team – one of the best in India. Unfortunately government organisations too often can end up with a good PR man on top who wins the job because of his interpersonal skills and loses the thread because he could not have had the focus to acquire the knowledge aspects. The other lacuna is not being seasoned in regards to industry practise.

An IAS can surely 'run' the 3/3 Gurkhas but will it then remain 3/3 GR? You need soldiering experience for that. This penchant of looking for a combined engineer and a leader was a problem in the private sector too and I remember one of the legends of modern thinking in the private sector of the eighties telling me, *après liberalisation*, rather ruefully, I thought, "We are trying to make engineering a rewarding profession" - and he was not prioritising pay!

The contours of the engineering leader

This quest for 'managerial' ability has sometime had the unfortunate effect of losing valuable innovators. One case from personal experience was of someone I shall call MB. MB was an engineer who had worked on avionics in the UK. In India, much respected, he developed and cleared to tight time scales many new airborne power electronics items. He then diversified into gyro-based land navigation systems. For twenty five years he spearheaded development of several generations of new equipment. Promotions came his way but when it came to the top slot, the Head of the Division it was felt –and I be no judge- that his rather informal, approachable style of leadership would not be suitable for such a 'management' job. The upshot was that on being denied the Divisional Head's job MB resigned and left. Looking back, both the contenders were sympathetic, honest and had the best interest of the concern at heart and yet both lost. MB lost the job he was passionate about and the company lost an incredibly rare resource.

Creating people

Creating people by launching a set of carefully graded tasks may seem to be impracticably long processes but actually it is really not more than ten to fifteen years. Even during this period a lot of serviceable equipment can be developed. After all we import 70% of our needs so why not take the band between 31 to 66 percent of equipment for creating our 'Next-gen' leaders? The case of Sir Stanley Hooker merits elaboration. Dr.Hooker at the age of 31 went to work for Rolls Royce in 1938 where –possibly overqualified and "not much of an engineer" (his boss's words) - he was left alone to make himself useful. He started work on improving the supercharger of the Merlin engine. He was brilliantly successful which led to his being involved in the design, in 1940, of the Whittle jet engine's centrifugal compressor. Note both the connection and the change. By 1945 he had started work on the axial flow Avon and following development troubles with the Avon in 1951 for which he felt he was being blamed, he left RR to work with Bristol Siddeley, where the 'Grecian' engines – Proteus, Orpheus, Olympus and the Pegasus followed. Incidentally like Petter, Hooker's had a strong 'India' connection through the Nene, Avon, Orpheus and the Pegasus, not forgetting the Merlin and Griffon. After his retirement from Bristol Siddeley, RR was not too proud to call him back to set right the problems of the RB211 which had bankrupted RR. Incidentally Hooker – whom people argue was one of Britain's greatest Engineers rivalling Brunel – never became Director of Engine development and when he died his obituary (and someone old and knowledgeable told me this) got less notice than the poet John Betjeman who happened to die on the same day.

The important ingredients of this story are of freedom to indulge in a passion, freedom to move to related field after rigorous proving (Whittle Compressor) rapid censure (Avon problems) despite near legendary (Merlin work) status, moving and contributing in different organisations (Bristol) and not mixing up management with engineering. Note also the proving and re-proving of the man in short term crucial challenges during which Hooker contributed significantly to the survival of the RAF and Britain itself. Of course Hooker was not anointed to succeed; there were many 'also rans' but they were allowed to fade away when they failed the punishing pace. There is a lesson in that. "The private sector should take over" is not a magic bullet in itself but the private sector has the advantage in that admittedly all processes are quicker but a major factor is no one is proof from firing or at least 'pasturing'. The assessment is continuous, remorseless and if needed, career wise, lethal.

It is the fairness that succeeds.

Song of the sirens

Investments in technology are directed not towards crying needs of operations but by the needs of marketing. The heralded technology menus of the 'sixties such for example VG today seem either 'con' jobs or impractical dead ends. High technology, stemming from requirements of international marketing is as necessary to us as the change of hockey rules in 1959 when we allowed the game to be taken out of our hands. Recent wars reinforce doubts of the need for technology. The Afghan mujahadeen, usually not avid readers, are not only unaware and unimpressed but are dictating the agenda. The Iran UAV affair provokes thought about the 'invincibility' both of stealth and UAVs. Here was a small stealthy craft which was located, identified and then downed. Further work will open the way for the Predator to be *cheaply* downed by a mix of optics, signal monitoring and crude 'Sidewinder level' technology. I say crude because a ground based system does not have to have the same Pk as an AAM. Launch a salvo of semi stupid missiles and get the bu**er! Capital *plus* Casualties presents World Power ! The US by compulsion, is trying to substitute Capital for Casualties and they are already on the wrong side of the drag curve. We have no needs, no means and no justifications. It would be much better for us to prioritise the development of leaders first and technology afterwards.

Desirability of small bottoms

As no doubt instantly grasped, the heading refers only to the days of capital ships when the big debate was the proportion of the budget to be spent on small ships. Capital ships generated sea power but the 'small bottoms' nurtured a *pool* of seasoned commanders. The problem with big defence projects is that they create a financial dought which favour the select few excessively but fail to create the larger pool. The bigness of the projects made the process exclusive. We could not finance the creation of more leaders.

The question may be raised that does a small project have sufficient 'bite' to challenge the leader? Yes, because in any design there are two elements : one is the definite quantifiable aspects related to the technological problems which can be tackled by increasing the size of the team. The other is which we may call the unquantifiable 'spiritual' aspect of the decision making process. This requires acute knowledge of the 'technical ecology' in which the design must serve. It is this 'spiritual' aspect which is the more elusive, difficult and which is identical in its quality irrespective of whether the project is big or small. Prof. Kurt Tank of the Marut, Max Holste of the Bandeirante and the Russians of the Brahmos supplied the spiritual aspect of these successful projects. If this 'spiritual' skill is not there, one can have a light trainer being overweight and long delayed just as much as one can have a jet fighter overweight and long delayed.

Developing this 'spiritual' aspect is vital because in design the answer is right only in relation to its *technical ecology*. The Me-109 used stressed skin, the Hurricane had steel tubes and the Lavochkin La-3 used delta derevezina-resin and bakelite impregnated birch ply for the airframe. Despite such a variety of answers, they were not fully competitive nor were they the 'right' answer for their technical ecology. The Bucker Jungmann/ Jungmeister and the Pitts Special were superb aerobatic biplanes. In the quest for lightness the designer of the Jungmann used *nineteen* sizes of tubing for his fuselage. The Pitts used four. Who was right? The answer is that both were right and displayed mature understanding of the technical ecology in which their designs would have to survive. Such skills require nurturing and development and small time bound projects are actually better for this.

Broad basing of leadership

Small, low-cost projects gives opportunity to a greater number of people so that finally we have a pool of seasoned leaders identified not by 'connections' but on results. The beneficiaries from the present dispensation would argue that a light aircraft cannot lead on to much. History proves them wrong ! In the 1920s, Camm, Yakovlev and Messerschmitt were designing two seat aircraft : the Hawker Cygnet, the AIR-1 and the M17 (170 kg, 25 kW!) which today would be considered as micro lights! Ten years later they were onto designing what were cutting edge technology fighters : Me-109, the Hurricane and the Yak-1, via a succession of small projects. In the 'forties they were onto jets. The fifties and sixties saw them onto VTOL jets which are as complex as one can get. Note the thirty year time period from ultra light to VTOL, same as our LCA project ! They succeeded because it was the small projects and *small stakes* which had steadily honed their skills and self confidence possibly (even better than big projects) which would create awe and overwhelm skills of the inexperienced. In the 'sixties Russia impressed the world with the boldness, extent and quality of its rotorcraft programme. This was the result of careful *single minded* strategic planning. In the preceding fifteen years, Russia had built no fewer than nine different 'low-cost' prototypes which explored various facets of vertical flight technology. Each programme was fairly small e.g. Kamov's Ka-10 had his trademark co-axial rotors seen on our Naval Kamovs but was powered by a 34 hp engine similar to that of the BMW motorcycle! Each project had a time scale of about three years. Four successful survivors from these pioneers, Bratukhin, Kamov, Mil and Yakovlev (who happened to be much favoured by one Tavarich Iosif Dugashavilli) were only then given official requirements to be met. Of these two, Yakovlev and the academician Brathukin tried, came second and were quickly relegated. The other two went on to serve *en bien merite*. The key management points were: the process was ruthless, inclusive, determined and fair. The Soviet Union did not back losers nor did they have only Brathukin. In comparison the efforts to develop an Indian tank engine was confined to CVRDE without competitive participation of VF Jubbalpore or GRSE or even within CVRDE, let alone the private sector. Without competition, without time lines, projects can became a version of MGNREGA (rural employment generation) schemes for people concerned. There should be a shift from big mega projects with infinite and independent time lines to numerous smaller 'tighter' projects. And remember, Tikhomirov was moved out after three years.

The China Model

As long as the present dispensation has 'the mandate of the Heavens', China has two great advantages. One is the vast in-country market .When the Chinese ARJ-21 with its shrewdly selected technical menu is cleared for service there will be no dearth of orders. If we were to develop an airliner, we can only count on a few dozen-odd compulsory orders from the Air Force. With that kind of a production run there will be no price advantage and no private airline will buy just to 'buy Indian'. The other great advantage is that the Chinese Government, having no elections to fund, is in full control in the same way the Nehru cabinet was in the 'Fifties. So whilst Chinese technical strategy can be applied, we need to remember their ecology is significantly different and this needs to be factored in our planning.

There are no international standards

Much is made of 'international' standards but the truth is each nation has significantly modified the rules according to its technical ecology. For example in the West, nine seats are what is permitted in a single-engine aircraft. There are safety reasons based on the surface transport speeds obtaining in the West. In Russia they have no such limits and An-2s operated with 14 people in certain roles. The British home builder has to use a certified welder and in America they do not bother. Are US homebuilts unsafe? The Russians rely on GOST and do not have a 'release note' for materials. The US allows use of standard automotive components if it suits the designer. Without a study and understanding of the ecology we end up by with a 'least area' approach which trammels development of our own thoughts and philosophies. The Western rules are in any case made for the World Market and so our own rules for our conditions, can be a judicious *subset* of theirs to make flying more affordable.

What could be the projects?

The main purpose would be to generate the people and will fail if people are allowed lifetime tenures. Like Tikhomirov or even Sir Stanley, non 'trotters' have to be weeded out or posted out and the project given a new leader. The max time allowed

till first prototype flight would be three years; this is reasonably tight but very possible. The average budget would be less than a few hundred crores. The projects will focus on developing the 'spiritual' aspects by using proven technologies. My *abridged* pipedream list would be the

Light aeroplane engine

Difficulties with 100LL Avgas are such we may soon stop having flying clubs. The aim would be to use existing automotive diesel engine technologies to create a 60-250 hp range of low cost light aviation motors. Interestingly at HVF we have the technology of the most proven of all aviation diesels, the Junkers Jumo 205. Upgraded with current technology e.g. CRDI, improved turbocharger and new *mastered* metallurgy, it could be the basis for the smaller designs. Automotive-based Mogas engines can be developed despite known problems such as vapour lock which can be tackled by innovative system design. The Shvetsov M11F, 5 cylinder radial of 115 /160 hp is worth mentioning. It was some thirty percent heavier than contemporary US engines but could run with unfailing reliability on poor quality, 45 octane petrol and 136,000 were built over three decades.

An upgraded Avro 748

Essence of the idea would be to convert the airframe to use current technology turboprop engines and propellers plus any other systems which can be upgraded within the given budget and time scale. Given the improved propulsive and weight efficiencies a fuselage stretch to increase the seating capacity to 70-100 could be incorporated in the same style that Baasler has modified old Dakota airframes.

An upgraded Orpheus

There should be a paper study as to what will be the gains if all the current *mastered* technologies - hybrid mechanical/ electronic fuel controls if not FADEC, new afterburner, air blast combustors, new materials, SC blading, gear box PTO etc – were applied to the veteran Orpheus? By a rough estimate a cold thrust of 30kN and a TBO double the old figure with a 20% improvement of SFC would be possible. If the results look good a prototype could be built and tested. If it lags as usual then the project could be shelved within three years as there would be no requirement to fulfil. It might appear silly to dig up the old Orpheus but this was basically a simple engine and would respond well to new technologies. Importantly there would be enough old engines available to at least bench run a few prototypes and to remember is that the 'product' sought is *leaders* who can deliver within time rather than the *engine*. Generally anything completely made in India will be between five to ten times cheaper than any western engine of similar thrust. Do you really need 5000 hr TBO if you get a bird hit or FOD at low level every 700 hrs or so? What about work on low level survival ability of turbine engines ? But please, it should be a focussed programme.

A basic trainer

Given the 'point one percent' rule i.e. each flying hour costs one tenth of one percent of the purchase price of the aircraft the Pilatus PC-7 will soon go the way of all jet training i.e. too expensive for weeding out the 'two left feet and two left hand' type of no-hopers. My personal choice would be a state of the art all-metal, Tiger Moth or a Bucker Jungmann-type with safe docile handling and good aerobatic capability for those who are so inclined. It could use the light aircraft engines mentioned above. Here the Yak-18 philosophy is worth a mention. It's structure appeared crude, its performance was hardly spectacular but the engineering was very sound and very sturdy. Though a *basic* trainer, it was comprehensively equipped with retractable undercarriage, pneumatic brakes and flaps and full blind flying instruments. It was stressed for full aerobatics including flick rolls and reportedly had beautifully harmonised controls. Built in huge numbers it provided at low cost a vast pool of trained pilots and mechanics for the Soviet forces. By introducing and enabling a large part of the population to be involved in the joys of aviation, its net impact on the shaping of airpower must have been profound.

An all metal glider

Instead of trying to equal the work of the Germans on *glasflugels* and delaying forever, what is needed is a simple sturdy all metal glider of sufficient performance, a circuit of the airfield after a winch launch so as to introduce the youth of our country to the thrills of flying at the lowest cost .

This list is only an indication of the way to go in developing the 'spiritual"'aspects of leadership. Since they are not tied to any specific re-equipment need, they can be closed instead of continuing funding. Obviously the project should be given essentially to existing organisations including those in the private sector and those industries not currently associated with defence or aerospace work.

Our current approach, based on the ill conceived plan that the one high tech project will succeed if persisted with has not been too successful. Come 2017, with the Bisons gone, the IAF may have to use the Hawk for the close support role. The Hawk may do so adequately (if with heavy losses) but that was not what we planned for. It is stupidity to repeat past mistakes and expect different results. *We must change tack*. We must make the process more "democratic". We must stop the failures early. In all military technology we must 'grow' leaders first and technology will follow. This is the quicker and more certain way to success.

Artist's depiction of the proposed Avro 748 rear loader tactical transport

Prof. Prodyut Das

PLUS AESA & METEOR

An even more potent Rafale

Extremely rare view of a French Air Force Rafale B with a single MBDA 3 kiloton ASMPA thermonuclear missile in the central position, plus 4 MBDA Mica air-to-air missiles. The aircraft is in full nuclear strike configuration with a pair of 2,200 litre drop tanks. Pictures with nuclear weapons are hard to come by. (Official Armée de l'Air photo - SIRPA-Air)

Till very recently it was only US fighters that could boast of new generation airborne radars. Among these aircraft with this great asset are the Lockheed Martin F-16E/F Block 60 Fighting Falcon (using the Northrop Grumman AN/APG-80 AESA radar), the updated USAF late model Boeing F 15C, Republic of Singapore Air Force's F-15SG (fitted with the Raytheon AN/APG-63(V)2 and AN/APG-63(V)3 respectively), the Boeing F/A-18E/F Super Hornet and EA-18G Growler (equipped with Raytheon APG-79 or APG-82(V)1). The Americans now have a 'rival' in shape of the French Air Force's Rafale F3 fighter, fitted with the Thales RBE2/AA (*Antenne Active*) AESA lightweight radar. Rafale F3, the first European fighter to be fitted with AESA radar, was inducted in the French Air Force in 2012.

On 1 October 2012, Dasault Rafale C 137 single seater aircraft, equipped with the new Thales RBE2 active electronically phased array radar, was delivered to the French defence procurement agency (DGA) virtually on schedule. The ceremony took place at Dassault Aviation's Mérignac production plant in Bordeaux, France.

A committed research and development programme coupled with sustained application by the French industry have been behind the Rafale emerging as the first European combat aircraft with a functional electronically phased array radar and a completely indigenous hi-tech sensor. Other European efforts relying on non-European technology are still at various stages of development and testing. Ericsson's PS-05/A MK-5 (NORA) for the JAS 39 Gripen and Euroradar's Captor-E CAESAR (Captor Active Electronically Scanning Array Radar) for the Eurofighter are two examples.

French Air Force Général Joël Rode, commanding officer of the *Centre d'Expériences Aériennes Militaires* (CEAM) at Mont-de-Marsan is "completely satisfied" with the upgraded aircraft. He heads the French Air Force test centre where the aircraft will undergo an eighteen-month period of operational air trials. The Général has declared, " Our Rafale F3 is already a splendid multirole fighter aircraft, it will be even better with this new radar. To be frank, this technological step is even higher than when we switched from the Thales RDI radar to the RDY on the Mirage 2000 fifteen years ago!" General Rode's testimony carries a lot of weight as his credentials include being the commanding officer of

DASSAULT

Escadron de Chasse 1/2 *Cigognes*, the sole French Air Force squadron to fly the Mirage 2000-5 air superiority fighter equipped with the Thales RBY multi-target agile Doppler radar cued to the MBDA Mica air-to-air missile.

The new RBE2 AESA brings to the Rafale F3 an extended range of capabilities like low-observable target detection, full use of new weapon systems such as the new MBDA Meteor long-range BVR hypersonic air-to-air missiles, a much higher reliability with relatively low maintenance costs and greater waveform agility for SAR (Synthetic Aperture Radar) imaging and improved resistance to jamming.

The *Armée de l'Air* will be followed by the *Aéronautique Navale* to acquire the aircraft joining the flight testing programme with EC 5/330 "Côte d'Argent" and CEPA/10S at Base Aérienne 118 in Mont-de-Marsan early in 2013.

All export versions of the Rafale, including the 126 earmarked for the Indian Air Force's MMRCA programme, will incorporate Thales AESA advanced radar technology as standard. This is consistent with the present F3-O4T standard (previously known as the 'roadmap' standard), which in fact is the latest standard retained for the sixty Tranche 4 Rafales earmarked for France. In short, 25 Rafale C single-seaters, 25 Rafale B duals and 10 Rafale M ship-borne variants for the *Aéronavale*, will be delivered between 2013 and 2019.

In France, the first operational squadron to acquire the Rafale with new radar will be EC 2/30 *Normandie-Niemen* at Mont-de-Marsan whose proximity with the CEAM will help resolve teething problems that might occur during the initial period.

General Rode is of the opinion, that "Since the new radar is of the 'plug-and-play' type, there will be no problem in operating both the old and the new types of RBE2 radars, PESA and AESA at the squadron level. Furthermore since all Rafales now use the NATO Link 16 tactical data exchange network, aircraft engaged in an aerial operation will benefit from the 'big picture' painted by those Rafales fitted with the RBE2 AESA." With Link 16, all Rafales as well as Mirage 2000s can exchange their 'tactical picture' securely in near-real time. The frequency range used by Link 16 today limits the exchange of information between aircraft within line-of-sight (LOS) of one another, but this is not considered a major issue in current military operations, particularly since tactical staging of fighter aircraft is always performed within the detection range of a Boeing E-3F AWACS.

The new MBDA Meteor Beyond Visual Range (BVR) air-to-air missile is the latest addition to the Rafale's weaponry. (MBDA photo)

A smarter radar

An active electronically scanned array (AESA) radar, also known as 'active phased array' radar, is that type of radar whose transmitter and receiver functions are composed of numerous independent solid-state transmitter and receiver modules (TRMs). Other components include an advanced receiver/exciter, ruggedised COTS processors, and power supplies. AESA radars simply aim their 'beam' by emitting separate radio waves from each module at certain angles which form a virtual sheaf in front of the antenna. Such radar is an improvement on the older passive electronically scanned (PESA) radar which emitted across a

much larger band of frequencies, making it difficult to detect over background noise and clutter. The Rafale with its AESA radar, will broadcast powerful radar signals to detect enemy aircraft or surface targets, while itself remaining unobserved. The complete 'electronic cloak' provided by the Rafale's Thales Spectra ECM suite, which is unique, is another advantage that this aircraft boasts of.

With Rafale C-137's intensive test campaign due to end during the summer of 2014, the CEAM will be able to tackle a brand new world of systems, armed with hi-tech systems like the DDM-NG devised by MBDA or the OSF-IT long-range optical passive identification sensor from Thales.

The DDM-NG (*Détecteur de missile de nouvelle génération*) demonstrated its high value some three years ago when a prototype DDM-NG began trials on-board the Rafale during the summer of 2009 at the DGA's test flight centre in Cazaux. Flight trials produced very convincing results, and the DGA ordered this new system as the standard fit for the 60 supplemental Tranche 4 Rafale aircraft ordered by France in December 2009.

As explains a DGA pilot: "The concept behind DDM-NG is the ability to detect incoming missiles from any direction and also the angle of attack from the host aircraft. It will supersede the current DDM system installed on the Rafale as a *form, fit* and *function* replacement." Characterised by two 'fish-eye lenses' fitted on both sides of the fin, between the Spectra EW antennae, the DDM-NG provides a complete 360° spherical field of view around the aircraft. It also incorporates a new IR array detector which enhances performance with regard to the range at which a missile firing will be detected. It also provides an improved rejection of false alarms (often produced by intense solar reflection on the ground or water surface) and gives a novel angular localisation capability which will be compatible with the future use of Directional Infra Red Counter-Measures (DIRCM) systems, the ultimate device to defeat incoming IR-guided missiles.

The quality of the DDM-NG's detection algorithms and its very low false alarm rate, allows it to be effectively incorporated within an integrated aircraft self-protection system such as SPECTRA (*Système de Protection et d'Évitement des Conduites de Tir du Rafale*) and to automate the sequence of counter-measures. In addition, operating in passive infrared, the DDM-NG has no electromagnetic compatibility issues with other sensors and can therefore be easily integrated into all aircraft platforms.

The new Thales RBE2/AA radar is the first European-designed AESA radar to be installed on a production fighter aircraft, in this case Rafale C-137, the 111th production Rafale. The new radar is more robust and provides the Rafale with a better detection range. (Thales photo)

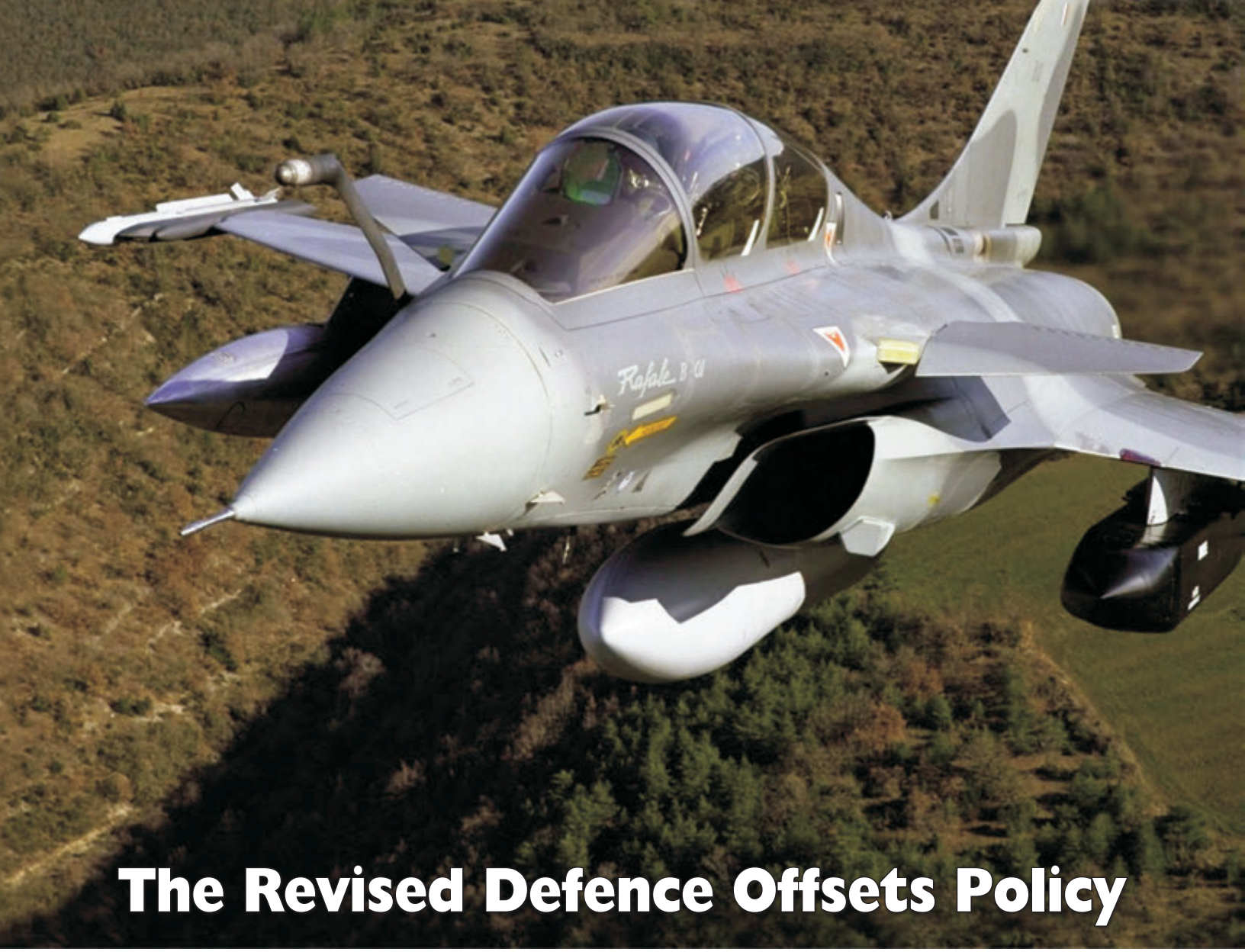
Adding more punch

Along with the new AESA radar, the Rafale F3 has also recently been cleared for the MBDA Exocet AM39 Block 2 antiship missile, thus adding more punch to the aircraft. Both the French Air Force and Navy Rafales are now compliant with this missile.

Significantly, in October 2012, a Rafale testbed (B-301) performed the first live firings of the MBDA long-range BVR Meteor air-to-air missile, at Cazaux AB on. The Meteor is now achieving its final acceptance trials, with the first deliveries earmarked for early 2013. This new missile is an exclusively European endeavour, with a team of engineers from Britain, France, Germany, Italy, Spain and Sweden, to be fitted as the standard long-range BVRAAM to the Eurofighter, Gripen and Rafale. France launched a procurement of a first batch of 200 Meteors in December 2010.

The Meteor is an active radar guided beyond-visual-range Mach 4+ air-to-air missile that will offer a multi-shot capability against long range manoeuvring targets in a heavy electronic counter-measure (ECM) environment. The Meteor's active radar seeker is derived from MBDA's highly agile Aster and Mica air intercept missiles. According to MBDA, this new missile has three to six times the kinematic performance of current air-air missiles of its type. The key to the Meteor's exceptional performance is a throttleable ducted rocket (ramjet) manufactured by Bayern-Chemie in Germany. For a CAP sortie, each Rafale will carry two Meteors altogether with six Micas, making it a formidable air superiority fighter.

Jean-Michel Guhl in Paris



The Revised Defence Offsets Policy

All Indian eyes on the Rafale programme, with Dassault having to discharge massive offset obligations

The Ministry of Defence (MoD) has announced the revised offset policy as a part of Defence Procurement Procedure (DPP) which came into effect on 1 August 2012. After much speculation, the revised policy brings some clarity to the defence offset procedures while trying to strike a balance between the demands of the foreign Original Equipment Manufacturers (OEMs) and the interests of the domestic defence industry. The offset policy which began its journey in 2005, now appears to have reached a sustainable degree of effective operationalisation. Then Minister of State for Defence, MM Pallam Raju, told parliament on 14 August 2012 that Indian companies have signed 19 offset contracts with foreign vendors since the offset policy came into effect in September 2005. Indian Air Force procurements have generated 80% of all offsets, with naval procurements accounting for the other 20% whereas army procurements have yielded no offsets so far. Most of the Army procurement programmes have been below the value of Rs 300 crores, on which offsets are not applicable. However, there are many big ticket deals in the pipeline where offsets will be utilised, and the Army has already started working on them.

Several amendments have been made in the existing policy with an objective to make the entire procedure more transparent and effective. According to the new guidelines, the responsibility of defence offsets is divided between two organisations: the Defence Acquisition Council (DAC) will evaluate the offset proposals and finalise the contracts whereas the Department of Defence Production (DDP) will be responsible for implementation of offset contracts including monitoring of progress. A new organisation, Defence Offset Management Wing (DOMW) has been established under the DDP, which has been assigned the responsibility of offset contract management. A similar organisation, Defence Offset Facilitation Agency (DOFA) was established in 2006. However, it was never able to perform the basic duties assigned to it. DOMW will have to carefully chalk out a clear charter of responsibilities as any ambiguity will lead to underperformance and red tapism in the process. MoD officials opine that the new organisation will function through a fully automated system that will monitor, account for and audit offsets in real time. If web-based monitoring is implemented, it would be very beneficial to the government and the industry. However, past experience of some online applications introduced

by the government hasn't been up to the expectations of the stakeholders. Therefore, it will need dedicated and sincere efforts by the officials of DOMW to put the execution process on the fast track.

The scope of discharge of offset obligations has been widened to include Transfer of Technology (ToT). The provision of ToT is expected to benefit the Indian Defence Industry to a great extent. However, it is to be seen if ToT can actually help the defence industry grow and realise its dream of self-reliance, envisaged more than a decade ago by the Kelkar Committee. The provisions for ToT have existed in earlier defence procurement programmes but the implementation did not take place along expected lines. The experience of our indigenous industry in absorbing and ultising the technology received from foreign OEMs has been inadequate. One such example is the BEML-Tatra deal which was signed in 1986. It is learnt that despite ToT agreement with Tatra, indigenisation of the vehicles remained far below satisfactory levels. Another such example is the Bofors artillery deal which was made two and a half decades ago. Till date, the Ordnance Factory Board (OFB) has not been able to develop the 'homegrown' version of the Bofors guns. Lack of accountability and monitoring has been the main reason for non/under utilisation of ToT provisions. The OEMs believe that India is not yet capable of absorbing the heavy flow of offsets through the ToT mode. Though the ToT provision seems promising, there is no guarantee that India will be able to make full use of it, considering its inability to do so in the past.

Another change has been the assignment of multiplier values wherein a multiplier value of 1.5 is permitted where Micro, Small and Medium Enterprises (MSMEs) are Indian Offset Partners (IOPs); multiplier of 2 when technology is offered to Indian Armed Forces; 2.5 when technology offered is for both military and civil applications and 3 when technology is offered without any restrictions to export. A list of 15 specific high-end technologies for acquisition by DRDO through offsets has been prepared. However, all these technologies have been placed at par and there is no further grading with respect to their multiplier value. The current definition of multipliers may not help India in gaining critical technologies. The foreign companies which invest considerably in R&D may not be comfortable in sharing them with India at a multiplier value of as low as 2. There is no specific incentive to share such high-end technologies as foreign OEMs can get the benefit of multipliers by sharing comparatively non-critical technologies. We need to provide higher multiplier values to extremely critical technologies required by DRDO in order to attract the foreign vendors. It may be helpful if MoD assigns multiplier values on a case to case basis based on criticality, importance, requirement and urgency. With the current policy, certain OEMs might try to offer obsolete technologies which may have little relevance for the defence forces.

The Defence Minister and the MoD have been emphasising the need for transparency and probity in defence procurement procedures. However, after signing 19 offset deals so far, the status of most of the contracts is still not known. It is difficult to understand the logic behind hiding the details and progress of offset contracts. In fact, the defence industry and OEMs should be made aware of the outcome of each project so that they can learn from the problems of previous projects and take appropriate measures. This would also help the industry to understand the trends in offset projects and prepare accordingly.

Other significant modifications in the revised offset policy, like increasing the time for bank offset credits to seven years, extending the time duration for offsets' discharge by two years, investment in 'kind', and limiting some penalties on vendors who fail to discharge offset obligations have been welcomed by the industry.

The revised offset policy has received a positive response from the industry, specially the OEMs. The long standing demands of the foreign arms vendors have been incorporated in the policy, while simultaneously protecting interests of the indigenous industry. However, some segments of domestic industry have been apprehensive of the dilution of offset objectives and feel that widening the scope of offsets may lead to digression from the original aim of self-reliance in defence. Since the scope of offsets has been widened to include inland/coastal security, civil aerospace products and services and so on, some analysts believe that even non-defence products and services would qualify for offset obligations. Therefore, the foreign OEMs will try to find the easiest way out to discharge offset obligations, which will be tangential to achieving the ultimate goal of establishment of a home-grown defence industrial base.

Pilatus PC-7 Mk.II: their offset obligations could well have been directed to support the HTT-40 basic trainer aircraft programme.

Although the revised offset policy has incorporated a wide array of reforms addressing concerns of the largest set of stakeholders, but with new changes arise new challenges. The MoD should keep the communication channels with the industry open to receive their feedback and recommendations periodically and to derive optimum gains from the offset projects. This may also help the MoD to address relevant issues and revise the policy accordingly in future, to garner the benefits of offsets and ultimately achieve the objective of self-reliance and military modernisation in a time-based manner.

Karanpreet Kaur
Research Intern at CLAWS

MODERNISATION PLANS

Exclusive:

VAYU

Interview with

Dr RK Tyagi, Chairman,

HAL

HAL and Sukhoi are to jointly develop and produce the fifth generation fighter aircraft (FGFA) for the Indian Air Force from the baseline PAK/FA (T.50) aircraft meant for the Russian Air Force.

Dr RK Tyagi, Chairman of HAL

VAYU : Having taken over as Chairman HAL earlier this year, can you kindly enumerate your priorities for the immediate future and some major challenges ahead ?

Chairman : It has been over 10 months since I am in the office now. The defence aerospace industry in the country has continued on a growth path owing to the modernisation and expansion plans of the Indian Armed forces. We expect this trend to continue.

At HAL, major development projects like the Advanced Light Helicopter weaponised version, Intermediate Jet Trainer, Light Combat Helicopter (LCH), Light Utility Helicopter (LUH) and Light Combat Aircraft (LCA) are entering their intermediate or final phase of development. Projects like development of the Basic Trainer Aircraft (BTA), co-development projects like Fifth Generation Fighter Aircraft (FGFA), Multi-role Transport Aircraft (MTA) and licensed manufacturing of Medium Multi Role Combat Aircraft (MMRCA), have been initiated and their preliminary activities have commenced. The immediate challenge for HAL is to put in place the right mix of resources to ensure the smooth progress of all the new and current projects and meet their time and cost milestones.

With opening up of the defence industry to private players and growth of private industry in the defence sector over the past decade, HAL moving from being a vertically integrated industry to an aircraft integrator with established supply chains rooted in the private defence industries of the country. The company has drawn up plans to outsource more than 30% of the manufacturing tasks. This would enable HAL to use the capacity more optimally and focus on core competencies and high value added jobs.

India's defence modernisation and expansion plans give 'Offset Opportunity' for those businesses engaged in defence related activities. The projected Offset opportunity market in the aerospace and defence sector in India is estimated at $ 30 billion over the next 10 years. HAL will strive to garner a major share of the offset market opportunities. If required, the company will set up a separate unit as a SBU to cater to the offset market.

The Dhruv ALH is arguably the current 'flagship' programme of HAL

UAC

We have identified Unmanned Aerial Vehicles, the civil aviation sector and development of Nasik airport for commercial operations as areas of strategic interest having immense business potential. We have arrived at this based on our market analysis reports and growth prospects. This is in addition to take advantage of offset opportunities, setting up of separate business groups we plan to establish. The market dynamics and opportunities are analysed closely to enable HAL to foray into these sectors.

VAYU : In which manner could HAL assume much greater role in meeting the major aircraft and systems requirements of the IAF, Army, Navy, Coast Guard and other major aviation operators in the country with the minimal foreign dependence?

Chairman : I am confident that in five years from now, HAL would have the ALH (all variants), LCH, LUH, HTT-40, IJT and the LCA in its product profile. Later the FGFA and MTA will strengthen our product profile. We are also pursuing the IMRH project (10 tonne-class helicopter). Once all these projects are completed, HAL would be catering to the major requirements of our armed forces be it helicopters, fighter aircraft, trainers or transport aircraft.

On the systems and equipment front, HAL has initiated discussions with various OEMs to explore possibilities of collaboration for co-development and co- production of systems and equipments with an aim to reduce dependence on license production or imports.

'Green' Do 228 light transport aircraft for export to RUAG in Germany

HAL's Bangalore Complex has produced the Jaguar strike fighter and its two seat version since the 1980s and is now upgrading batches to Darin III standards.

HAL-produced Dornier 228 for the Indian Coast Guard at the Transport Aircraft Division, Kanpur

HAL is also contemplating on forming internal partnerships with Indian private industries in allied areas and technologies, in the aircraft platform manufacturing to widen the aerospace infrastructure within India.

HAL is involved in co-development and co-production of Fifth Generation Fighter Aircraft (FGFA) and Multirole Transport Aircraft (MTA) with the concerned Russian agencies. These two projects, when completed would provide HAL with an in-depth design expertise and the complete production technologies for a state-of-the-art fifth generation fighter and a transport aircraft.

VAYU : As perceived by many, HAL essentially remains a licence-builder of foreign aircraft and has not demonstratedly enhanced its capability for design & development of select aircraft types. Your comments, please!

ROLLS ROYCE

Dassault Mirage 2000TH : HAL has overhauled the IAF's fleet and will be upgrading the type to the new standard.

Indian Naval Sea Harrier : HAL's Overhaul Division was involved in the LUSH (limited upgrade sea harrier) programme.

Chairman: There are a few misconceptions that are being floated around on HAL. Let me point out that since its inception, HAL has developed 15 aircraft and helicopter types and has manufactured under license 14 aircraft and helicopter types. In addition, HAL has been at the forefront for product and technology development, manufacturing and assembly, system development and integration and repair and overhaul over the last seven decades in business. HAL emerged into a vertically integrated industry in the aerospace sector. Our R&D efforts are channelised in such a way that total product life cycle management is ingrained. More than a dozen types of aircraft and helicopters are manufactured under licence at HAL and most of them are fitted with various avionics, hydraulics and electrical systems evolved from HAL's own R&D efforts.

We need to create platforms to keep ourselves upgraded with current avionics, communication systems and sensors. Our challenges include maintaining operational relevance and fleet serviceability aircraft and helicopter types for around 20-30 years of exploitation. I am proud that several such timely upgrades and product improvement initiatives requiring developmental efforts have been successfully undertaken by HAL. Recent upgrade programmes completed are Jaguar Navwass, MiG-27M, Sea Harrier, Cheetal/Chetak Helicopters etc. New upgrade programmes in the pipeline include Jaguar DARIN-III upgrade, Mirage 2000 upgrade and Dornier 228 upgrade.

Accessories and Avionics and Engine Research Divisions of HAL have been doing commendable job in terms of development of various state-of-the-art and mission critical products in the areas of hydraulic systems, strategic electronics and avionics, communication equipment, Mission Computers, small Gas Turbine starters/engines, Engine Test Beds etc.

I am confident that the perception on HAL will get a big facelift when the indigenous products like IJT, ALH, LCH and LUH become operational in the near future.

VAYU: What is the share which HAL has been assigned in the collaborative design and development of the Fifth Generation Fighter Aircraft? What will be the major differences between the aircraft produced in Russia for their Air Force and those in India for the IAF ?

Chairman : HAL's share of work includes design and development of functional software, navigation systems, display systems, units of electronic

The Dassault Rafale (seen at Aero India 2011) has been chosen as the IAF's MMRCA and will be licence built by HAL at Bangalore.

warfare systems and some parts of the aircraft structure etc.

The FGFA is being developed primarily to meet technical specifications of the IAF although the Russian FGFA is the baseline platform for its development. In general, the IAF specifications are more stringent in terms of performance requirements, maintainability aspects and environmental qualification standards.

VAYU : It is learnt that Dassault Aviation, whose Rafale fighter has been chosen as the MMRCA, have recently asked the Ministry of Defence to "define" the role of HAL in the programme. Considering that bulk of the Rafales will be built in Bangalore, what is the practical timeline for various activities leading up to the delivery of the first HAL-built Rafale for the IAF ?

Chairman : As stipulated in the RFP, HAL is the designated lead production agency for the Medium Multi Role Combat Aircraft (MMRCA) project for the air-frame, engine and assembly of the aircraft and systems integration. HAL is the prime Aeronautical industry in India, which only has the technology and wherewithal to produce Rafale class of Aircraft.

The price negotiations of the MMRCA project have begun. The detailed scope of work allotted to HAL and the delivery schedule would be known after finalisation of contract between the vendor and MoD.

The process for setting up the required infrastructure for Medium Multi Role Combat Aircraft (MMRCA) project has already been initiated and HAL is gearing up to meet the challenging timelines.

VAYU : The Light Combat Aircraft has been under development for nearly three decades and the IOC is "imminent". Enormous expenditure on its development apart, the nation is deeply concerned not only on the delays but even on the "ability" of HAL to produce the LCA in quantity and at the quality required for operational service. Kindly tell us plans of HAL to produce LCA so as to meet urgent requirements of the IAF !

Chairman : HAL is the major partner to Aeronautical Development Agency (ADA) for the design and development of LCA. ADA is the designated lead designer / project manager for the development of LCA. ADA has indicated that IOC for the LCA is being planned to be achieved in the second quarter of 2013.

HAL is geared up to commence delivery against the current order for LCA within three to six months of the Initial Operation Clearance (IOC) certification of the aircraft. HAL has already set up the production line and has produced six limited series production

The multirole transport aircraft (MTA) is subject of a joint venture between HAL and UAC

The ADA-developed Tejas LCA will be productionised by HAL at its Bangalore Complex

aircraft pending final IOC. HAL is ready with the infrastructure to meet the immediate orders. Activities to ramp up the production from the present level to eight aircraft per year are also being taken care of. The company is planning to augment the production capacity up to 16 aircraft per year as we anticipate more orders in future.

VAYU : With the PDP contract of the Multirole Transport Aircraft programme formalised in October 2012, what immediate investments and plans are HAL making for its design, development and flight testing so as to meet the timeline for series production?

Chairman : I am happy to inform you that after the signing of the PDP

Contract, a batch of designers from HAL are in Russia and PDP activities have been initiated from 1 December 2012. The estimated design and development timeframe is six years and manufacture of this aircraft will be taken up at HAL Transport Aircraft Division, Kanpur. Presently, IT infrastructure requirement for design and development of the aircraft is being catered for at the Aircraft Research & Design Centre, Bangalore. Internal procedures are being set in place to estimate the infrastructure requirement at TAD Kanpur for series production of the aircraft.


Mockup of the HAL light utility helicopter (LUH)

VAYU: HAL has a number of promising rotorcraft programmes on the anvil, including the LCH and LUH, apart from variants of the ALH for the Army and Air Force. With delays in selecting a replacement for the Cheetah (197 helicopters for the two Services), will HAL put greater efforts in developing its own light utility helicopter including the engine selection which is a priority. Please elaborate on the status ?

Chairman : The Light Utility Helicopter (LUH) is being developed in the three tonne weight class and approval for the development of Light Utility Helicopter was accorded by Government of India in Feb 2009. The LUH project is running concurrently with other HAL designed rotary-wing projects like LCH, weaponised version of ALH .

Considerable progress has been made on the ab-initio helicopter design project slated to have the highest level of indigenous content in any helicopter made by HAL. The timeframe for development is six years. Several important milestones on LUH Design have been achieved. The process of selection of engine has crossed vital steps. Engine related design features are under finalisation. The first Ground Test Vehicle run is expected in December 2013. Presently, resources are being supplemented to meet the development schedule and customer requirement from the platform and initiate series production in time. We will ramp up the production facilities and efforts will be made to meet the timelines in case the option of producing 197 helicopters is made available to HAL.

VAYU : HAL must be disappointed at the recent MoD decision to foreclose the HTT-40 basic turboprop trainer project. Considering that HAL began preliminary design some years ago and have for long had capability of developing and producing training aircraft for the IAF, many feel this is a retrograde step for the future. Kindly comment.

Chairman : MOD has not rejected HAL's proposal. The sanction for the design and development of the Basic Trainer Aircraft is awaited. To save on the timelines, HAL has initiated the development activities with its own funding. Most of the preliminary design activities including configuration studies and sizing, cockpit layout finalisation, wind tunnel model testing have been completed. Fabrication of a full scale functional mock-up is under progress.

On the cost front, the estimated cost of HAL built trainer is comparable with the other basic trainer aircraft available today. The cost comparison should be done considering the "Life Cycle Cost" ensuring the maintenance support to the fleet for the next 30 years, in which HAL will be competitive.

VAYU : What is status of the Intermediate Jet Trainer : at what stage is the programme ?

Chairman : The Intermediate Jet Trainer (IJT) project of HAL is presently at an advanced stage of development. Two prototype aircraft (PT-1 & PT-2) and three Limited Series production aircraft (LSP-1, LSP-2 & LSP-3) have been manufactured. Flight testing has re-commenced subsequent to the design modifications from February 2012 after the loss of PT-1 aircraft. While this type of loss of aircraft needs to be avoided, such incidents of loss of prototypes have occurred in many such development programs undertaken in other countries as well.

HAL is making all out efforts to achieve the IOC at the earliest. The project is being closely monitored to ensure that any support / decisions required are given in a fast track mode. More than 600 flights have been completed so far. However, considering the number of test flights to be completed, the IOC is expected during the second half of 2013.

VAYU: HAL has paid Rs. 814 crores to the Government as a final dividend for the year 2011-12, which is by all accounts a creditable achievement as it is 675.52% of the paid-up share capital of Rs. 120.50 crores. HAL have steadily increased its turnover which in 2011-12 which was Rs 14,204 crore. What are the forecasts for the year 2012-13 ?


The HAL HJT-36 Sitara intermediate jet trainer

Chairman :We initially set our sales target at Rs. 15,000 crores for the Financial Year 2012-13.

VAYU: What impact will the proposed 10% of disinvestment have on HAL ?

Chairman : The decisions related to disinvestment are taken at the Governmental levels. However, we believe that the Disinvestment in HAL would be taken up after the authorities study the recommendations of the

Defence Minister AK Antony at the HAL Stand during DefExpo 2012, seen with Chairman RK Tyagi and MD Helicopter Complex Soundara Rajan

Expert Group on 'Strengthening and Restructuring of HAL'. The Expert Group has submitted its report to the Government.

VAYU: The healthy order book position of HAL is most commendable.HAL is also expanding with the addition of new factories/ Divisions at Kasaragod, proposed facility at Bidar for Helicopters. Your views on how HAL will tackle the ever rising demands/expectations from HAL!

Chairman : We have planned state-of-the-art manufacturing facilities for MMRCA, LUH and Medium Lift Helicopters projects. Centre of Excellence in Transmission and Composites and a separate factory for manufacturing engines for helicopters exclusively are also being conceived.

As I have already said, LCA production facilities will be augmented to increase the production rate up to 16 aircraft per year. Helicopter Division facilities too will be reinforced to take up the production of LCH in addition to the current production of ALH.

In addition, the Company is in the process of finalising the 'Modernisation Plan' considering the current and new programmes, the delivery

Light Combat Helicopter TD-2

schedules and the required rate of production. The plan will provide a road map for creation of new facilities, induction of new technologies, augmentation/upgradation of existing facilities to cater to the Design & Development and manufacturing activities.

The light combat helicopter (LCH) is under development to meet the critical high altitude attack requirements of the Indian armed forces.

We plan to outsource in a big way and HAL has drawn up plans to outsource more than 30% of the manufacturing task. This strategy would enable HAL to add and use the capacity more optimally on high value added jobs and new business opportunities.

HAL would like to enter into allied fields to widen its product and service profile. The company is pursuing strategic business alliances through partnership and Joint Ventures to gain access to technology and the global market. The company aims to leverage the Indian market to gain access to the global market.

The Helicopters

Mr Soundara Rajan,
Managing Director,
HAL Helicopter Complex

Pair of Indian Army Dhruv ALHs in formation flight during operational training

HAL's involvement with rotary-winged aircraft dates back to June 1962. To meet the Indian Air Force's requirement for light helicopters, the Government of India signed a licence agreement with Sud-Aviation of France (consequently re-named SNIAS or Aerospatiale and now part of Eurocopter) for production of helicopters, as also Turbomeca for production of its Artouste power plant.

The first helicopter type to be built at HAL Bangalore was the Alouette III, later named *Chetak*. Deliveries of helicopter commenced in 1965 with 'fly away' Chetak's to IAF. The 'raw material' production phase for the helicopters began in 1969-70. The Alouette II, with the dynamics including power plant of the Alouette III was specifically developed to meet the Indian Army's stringent requirement and was christened *Lama* by the French (and *Cheetah* by the Indians). The SA-315B licence-agreement was signed in September 1970. First *Cheetah* manufactured from raw materials was delivered in 1976-77.

# of HAL

The initial stages of helicopter manufacturing were carried out in the Aircraft Division with earmarked assembly department for the helicopters. A separate Division was established for the manufacture of helicopters, in July 1970. New buildings of the Helicopter Division were inaugurated by the then President of India, VV Giri on 17 July 1974.

The Allouette III (or Chetak) was the first helicopter type built by HAL at Bangalore

The Cheetah is licenced built Lama and virtually synonymous with the Indian Army at the extreme frontiers of India

The Indian Army operates several flights equipped with the HAL Chetak

The HAL Dhruv ALH undergoing high altitude trials in Ladakh

In an exclusive interview with *Vayu Aerospace & Defence Review*, Mr P Soundara Rajan, Managing Director of the HAL's Helicopter Complex stated that "requirement for helicopters is seen to double in the next decade. Significant design & development programmes are forecast for the helicopters with increase in the helicopter design, manufacturing and overhaul activities. With this, it was considered prudent to create a separate Complex for Design & Development of Rotary Wing Products.

The mandate of the Helicopter Complex encompasses production, repair & overhaul of Chetak, Cheetah, Cheetal and Dhruv helicopters as well as upgrades and future developments

Over the next decade, HAL's Helicopter Division produced 352 *Chetaks*, 275 *Cheetahs*, 10 Cheetals helicopters (re-engined Cheetah's). HAL is presently finalising a contract with the Indian Army for supply of 20 Cheetal helicopters (see news item in this Issue). In the year 2000, HAL launched series production of the Dhruv Advanced Light Helicopters (ALH) for the Indian Air Force, Navy, Army and Coast Guard as also for a number of civilian customers, including state governments, while a number of them have been exported to Nepal, Mauritius and notably to Ecuador. HAL has since produced more than 140 Dhruv helicopters and the Indian Army and Navy have indicated a requirement of another 61 Dhruv ALHs.

The Indian Army has ordered considerable numbers of the ALH-WSI, calling it the Rudra

The second prototype of HAL's Light Combat Helicopter

of helicopters : Design & Development of Weaponised version of the ALH (named Rudra by the Army), Light Combat Helicopter (LCH), Light Utility Helicopter (LUH) and the Indian Multi Role Helicopters (IMRH)."

The ALH-WSI programme includes integration of mission systems (Electro Optical Pod, Helmet Pointing System, Counter Measures Dispensing System) and Weapon Systems (20 mm Turret Gun, 70 mm rockets, air to air missile, anti tank guided missile) with other on-board systems like Integrated Architecture & Display Systems (IADS). Mission & Weapon systems have been integrated and tested in stand alone configuration to assess their efficacy. Also, the mission

EILBIT

As the Army expands its aviation corps, the Cheetah and Dhruv will be supplemented by the LCH and other HAL helicopter types in the near future

systems have been successfully integrated with IADS. The weapon systems in integrated configuration have completed all tests and Initial Operational Clearance (IOC) for the programme is expected during January–February 2013.

As for the light combat helicopter (LCH), Mr Soundara Rajan explained that "A total of 3 prototypes / technology demonstrators are planned. TD-1 and TD-2 are already flying and test schedules are in progress. The first batch of off-base trials were successfully conducted in June- July 2012. Further off-base trials such as cold weather and hot weather trials at high altitude in the northern sector are planned in the current year. TD-3 is under production and will be ready for trials by October 2013. With TD-2 & TD-3 available in 2013, rigorous Weapons trials are planned between the hot and cold weather trials, and the flight testing are expected to be completed by mid-2014."

As for firm orders, the Indian Army has indicated requirement of 114 LCHs while 65 would be for the Indian Air Force. "About 40% of the ALH systems are incorporated in the LCH. This includes mainly the transmission system, rotor system, propulsion and some of the electrical and avionics systems."

While the Indian Army/Air Force requirement for a high altitude reconnaissance & surveillance helicopter has still not been met, HAL has initiated the design & development of its Light Utility Helicopter (LUH). The 'Configuration Freeze' milestone was reached in June 2009, 'Design Freeze' milestone in August 2010. As Mr Soundara Rajan pointed out, "the design of Transmission and Rotor Systems is completed as a fully indigenous effort based on the experience gained through our ALH and LCH platforms". The Structure for the Ground Test Vehicle (GTV) is manufactured and ready.

The Indian Army/Air Force have indicated a requirement for 187 LUH but, this could well increase once the helicopter is certified. There would also be considerable demand for the civil variant of the LUH within India itself.

Finally, with the Dhruv ALH considered as "the flagship helicopter of HAL" and now operating with numerous squadrons of the Army in varying terrain, ranging from extreme altitude in the Ladakh region to the deserts of western India, HAL are fully conscious of the need for robust after sales support, providing spares and immediate AOG reaction, calibration and maintenance of equipment, training, documentation and all aspects of full life cycle support to the ALH fleet. So as to be closer to the customer, the Helicopter Complex Division have deployed contingents of fully trained technicians and technical officers at every major base of the operators for logistic and technical support including Ecuador and Mauritius.

Shape of the future : HAL's light combat helicopter (LCH)

RUSSIAN HELICOPTER

The Jaguar DARIN II

A concurrent engineering success story

Yogesh Kumar, then Executive Director of ARDC at HAL and presently Advisor on the National Civil Aircraft Development Project with NAL, describes at first hand the unique Jaguar DARIN II programme, an example of what can be achieved if complex aerospace programmes have clear objectives and are resolutely led.

This was perhaps the most ambitious and challenging of programmes undertaken by HAL on concurrent design and production with the author as Team Leader during the period 2002 to 2006. The programme was named as DARIN-II, being essentially upgrade of the Jaguar strike fighter's NavWASS (Navigation and Weapon Aiming System), to the latest Display, Attack, Range and Inertial Navigation (DARIN) system. The programme required trial mod on a selected Jaguar trainer and a single-seat strike version of the Jaguar, which including spares and ground test rigs was at a sanctioned cost of Rs 73.4 crore ($ 18.35 million) as per the RMS order given by Air Head Quarters.

The Jaguar DARIN-II programme consisted of a comprehensive avionic systems upgrade, integration of new weapons, advanced weapon delivery modes, new sensors and incorporation of 'hot standby' philosophy using two mission computers. In all, a total of about thirty new LRUs and systems had to be integrated. The programme broadly involved the following :

- System design and preparation of specification documents
- Algorithm documents
  Software design and development
- Development of Mission Computer and related LRUs
- Testing and analysis, including
  - Sub system level
  - Software integration
  - System integration on rigs and aircraft
  - Flight tests
  - Post flight analysis
  - Weapon trials in the field
  - Certification

development of the Mission Computer (MC), hardware and software with associated test equipment. The Aircraft Research and Design Centre (ARDC) of HAL was assigned the role of system design, preparation of top level system definition document, its integration on rigs and in the test aircraft leading to flight testing and, finally, certification. Other participating agencies were CEMILAC, DGAQA, Air HQs and its Aircraft System Testing Establishment (ASTE) and SDI, plus the Accessories Division of Hindustan Aeronautics Limited. HAL's Korwa Division awarded the contract to Smiths Industries of the UK (now part of the GE Group) for design, development and supply of the Mission Computer with associated test equipment.

Some 15 types of weapons were to be integrated into the Jaguar system, the majority for the IOC (Initial Operational Clearance) and remaining for the FOC (Final Operational Clearance) stage.

As the programme was initially envisaged, the Avionics Division of HAL at Korwa (near Amethi) was identified as nodal agency for design and

A number of interactions and discussions took place between HAL and Smiths, both in India and the UK, to finalise specifications and launch the programme. However, sometime around 2001, Smiths began to display reluctance to proceed unless the order value was re-negotiated and the prices increased; the reason given was "very frequent

changes in specifications to what was originally projected". HAL of course contested this. After the final negotiations with Smiths broke down, during the Farnborough Show in 2002, the then Chairman HAL NR Mohanty took the momentous decision that an indigenous route would be followed for development of the MC and associated equipment.

On his return, Chairman asked me (I was then Executive Director of ARDC) to lead this programme which would be carried out entirely through such an indigenous route. I was authorised to involve the Defence Avionics Research Establishment (DARE), a DRDO lab in Bangalore, for development of the Mission Computer, as DARE had earlier worked on MC of the LCA and had the required knowledge and skills. HAL's Chairman had already got consent of the then SA to RM, Dr VK Aatre. And this was how a historical decision for indigenous development of the complete DARIN-II programme was taken and the project launched with myself as the Team Leader on 7 September 2002.

HAL Chairman Mohanty also shared with me the letter from then Chief of Air Staff Air Chief Marshal S Krishnaswamy, which directed that the 17 Jaguar Trainers on order with HAL would be accepted by IAF only after they had been upgraded to the DARIN-II standard, a very big challenge indeed, as their deliveries involved eight aircraft in the production year 2003-04 and another nine in the production year 2004-05!

If this schedule was not met, it would mean a loss in HAL's sales revenue of almost Rs 700 crore in the first year and Rs 800 crore in the second year, a massive percentage indeed considering the total projected sales of Rs 3700 crore and Rs 4400 crore of the Company over these financial years.

Just imagine : we were re-launching the programme in September 2002, committing compliance of mods and deliveries of Jaguar trainers as per above schedule, which was considered very ambitious indeed. It quickly became clear that development and production would have to go simultaneously with very close monitoring. It took me a few days to compose myself as I hardly knew what I was leading myself and

ELISRA

my team to ! I already had very heavy commitments on the Light Combat Aircraft (LCA) and Intermediate Jet Trainer (IJT) programmes (the IJT's first flight took place in March 2003). Anyway, this was a directive from the Chairman and had to be honoured - there was no looking back!

So how did we go about it ?

The immediate task was to shift, en-masse, all the specialists and designers from the Korwa Division, who had worked on this programme, to Bangalore along with necessary hardware and software. This was done and a Software Development Centre was up and running within four weeks, by end-September 2002.

Responsibility for development of the Mission Computer with its related software and associated equipment was entrusted to DARE in Bangalore.

TIMELINE

Start of the programme	7 September 2002
First Flight with Version V1.0	29 September 2003
First Flight with Version V1.1	20 January 2004
Delivery of 8 twin seater Jaguars	31 March 2004
First Flight with Version V2.0	21 September 2004
Delivery of 9 twin seater Jaguars	31 March 2005
IOC of Jaguar NavWASS Upgrade (Strike and Trainer)	29 September 2005
First flight with Version V3.0	26 February 2006
FOC of Jaguar NavWASS Upgrade (Trainer)	15 September 2006
IOC of 20 Strike production Jaguar with integration of additional 10 LRUs	5 September 2006
Completion of all types of Weapon integration and accuracy trials at Jaisalmer	27 January 2007
FOC of Jaguar NavWASS Upgrade (Strike)	2 April 2007

MBDA

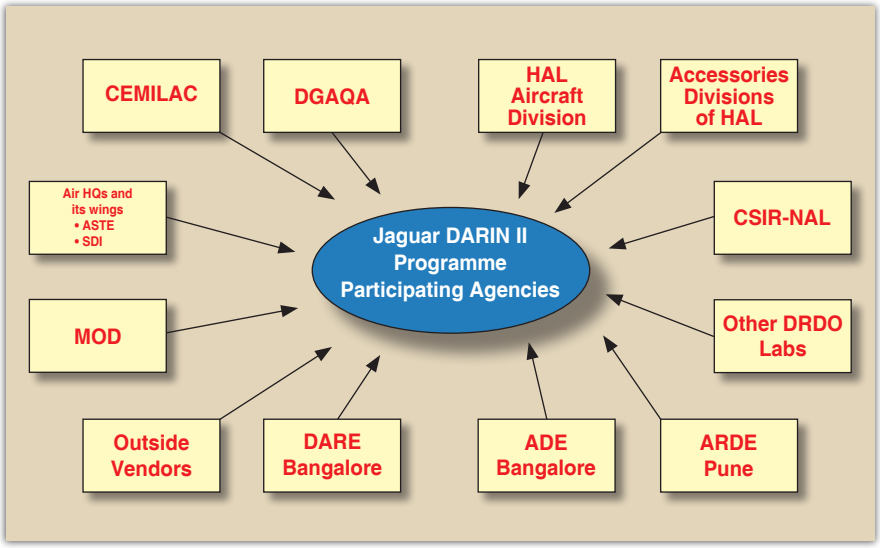
Appropriate teams were formed with each Team Leader assigned very specific roles and responsibilities. All were to work in parallel.

Tight Review mechanisms were put in place, with weekly co-ordination meetings with certifying agencies (CEMILAC and DGAQA), ASTE and SDI; weekly meeting with DARE, which later became daily ; daily review by myself in the Lab; at least two visits to the Prototype Hangar (in Aircraft Division) everyday and review of the project by the ACAS (Plans) at Air Headquarters at least twice a year - if not more.

Key challenges encountered

It must be emphasised that success of the programme was entirely owed to the synergies of various organisations involved with the project, with myself taking the role of a coordinator (participating organisations shown in box).

We had tacit understanding with CEMILAC and the DGAQA (CRI Aircraft) that while the trial mod was under progress, work on the production of twin-seater Jaguars would continue concurrently, the aircraft brought to the mod status and kept on standby.



Milestones

A total of 377 test flights were carried out on the trial mods incorporated in the Jaguar Trainer and Jaguar Strike aircraft from the HAL Airport in Bangalore, ADE's range at Kolar and also the Jaisalmer range of the IAF during the period 2003 to 2007. Major milestones achieved are given in the table, which is evidence of the fact that the entire programme was completed in record time, alongwith deliveries of production twin-seater Jaguars. The Mission Computer had one million bytes of source code.

It must be highlighted that IOC of the Jaguar Trainer and Strike Version was done within 3 years from go-ahead; FOC of Trainer Version was within 4 years from go-ahead and FOC of the Strike Version within 4 years and three months from go-ahead. To the best of my knowledge, these set bench marks even for International organisations.

There would be no stoppage of work for want of formal approval of the MoD.

Instructions were given to all concerned and aircraft then built with provisional clearances, a unique example of certifying agencies working in pro-active mode with total commitment to the programme.

While the responsibility for design mod was that of the Aircraft R&D Centre, line compliance was that of Aircraft Division. I had full support of Mr Ashok Saxena, the Managing Director of Bangalore Complex and normal interdivisional 'bickerings' were not allowed to surface. In fact the entire team from the Aircraft Division was technically reporting to me although it was administratively under control of the MD (BC). This was a very important aspect to ensure seamless transfer of design into production.

We also had to carry out independent verification and validation (IV&V) of the software for which we had to identify independent agency(ies). We approached BAe-HAL (a JV of BAe Systems and HAL) and ADA to provide such support. Both took up the challenge and the IV&V successfully completed. Even though the Jaguar was not part of ADA's programme, the then ADA head MB Verma, whom I approached for help, extended this immediately–such was the strength of relationship between HAL and ADA.

Somewhere downstream after the programme's launch, we found that aerodynamic data (Cl, Cd, Cm) in respect of some of the weapons was not available neither with Air HQs (SDI) nor with the ARDE Pune. This then had to be generated in the wind tunnel without which it was not possible to write the software. This could really have been a dead end, but thankfully, models for most of these were available. I went to Director NAL (Dr AR Upadhya) who agreed to help us out. The data was generated in record time of about ten days and, if I remember correctly, without any formal order from HAL. Again a unique example of what good relationships can bring to the programme!

After initial flying from HAL Airport Bangalore, trials with dummy weapons had to be done at ADE's Kolar range. However, ADE had then recently installed

some radar systems and therefore, was reluctant to let us use the facility for fear of this getting damaged. A word from the then SA to RM (Dr. Aatre) resolved the issue. Again, an example of good relationship created with the DRDO.

Somewhere in midst of the programme, there was a sudden surprise. Chairman HAL received a letter from BAe Systems (original designers of the Jaguar) stating that our mod was being done without their consent and could have major structural and system-related implications for which BAe Systems "could not be held responsible." Although we were a little apprehensive at the beginning, we decided to go ahead with full knowledge and support of CEMILAC and the DGAQA. The Jaguar DARIN II fleet has been flying since then with no incident reported so far.

Sometime around late 2003, when the trial mod was at its final stage of approval, a software bug was noticed. The CRI stopped further work (rightly so) until this was resolved after adequate testing. A meeting was held in New Delhi in the office of Joint Secretary (HAL) which was attended by the DCAS, CE (CEMILAC), Chairman HAL and myself. By that time, we had identified the cause but detailed testing was yet to be done. It was agreed that pending the

FUNCTIONALITIES AND DESIGN DRIVERS

- Full Navigation
- Hot Standby operation
- 1553 interface
- Deployment of weapons
- Integration of about 30 LRUs and systems
- Implementation of second MIL 1553 interface

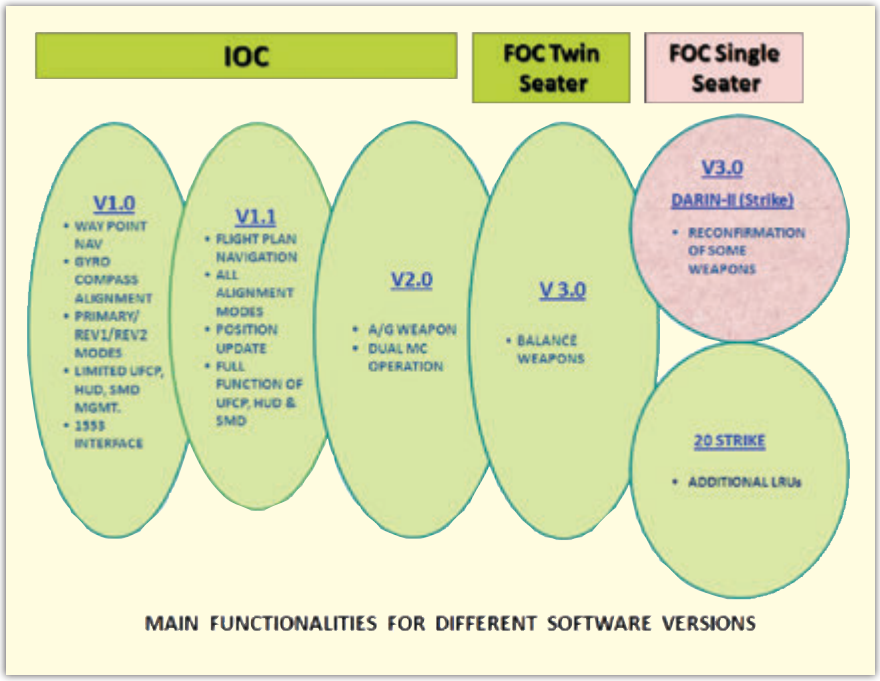
Design Drivers

The total upgrade design was made around two Mission Computers working in Hot standby mode. The Mission Computer (MC) performs:

- Navigation, Guidance,
- Weapon aiming & release,
- Electronic Warfare (EW),
- Display and Recording functions,
- The Mission Computer (MC) integrates upto 32 different units (number of units depends on the Version) covering Sensors, Display, Control, EW and Recording units to achieve state of the art Nav-attack system capability.
- The software is designed to provide fail-safe (no degradation due to single failure) mission activity using two MCs in hot-standby mode.
- The software is designed so that any one MC can be configured as 1553B Bus controller as well as Display driver for Head Up Display (HUD) and Upfront Control Panel (UFCP).
- Mission Computer Software is designed to suit the different configuration of Aircraft i.e., Single seater, Twin seater (Trainer) or Maritime version.
- Mission Computer Software is designed to ensure failsafe mission execution for failure of any of the interfacing unit.
- The software is designed to provide navigation information, guidance as per selected destination & flight plan and update of position and inertial errors.

Sqn. Ldr. Baldev Singh (right) then Chief Test Pilot at HAL's Bangalore Complex with Mr. Pant, GM Aircraft Division.

Left to right: Yogesh Kumar, Ashok Baweja (Chairman HAL), Ashok Saxsena (MD-BC) and Maj.Gen. Ashok Mehta during the handing over ceremonies of Darin II Jaguars at HAL, Bangalore.



MAIN FUNCTIONALITIES FOR DIFFERENT SOFTWARE VERSIONS

endurance test, the mod would be cleared for Bangalore-based flights. The very next day, paper work was initiated to implement the mod and clear the series production aircraft which remained on standby for flying.

However, the DGAQA had a different view, which wanted LMC (Local Modification Committee) to approve the mod in the line-production aircraft. It normally takes about four weeks to hold such LMC as it constitutes members from various organisations including some based outside Bangalore. In this case it was organised in just two days. The LMC met at 1100 hrs in Aircraft Division and by 1300 hrs, the mod was approved for compliance in the line production aircraft. The same afternoon, flights started on twin–seater Jaguars. This was in February 2004. Chairman Mohanty who was then visiting Kanpur was informed of this milestone achievement.

Almost sixty test flights were conducted between February and end-March 2004 on Jaguar series production aircraft. We wouldn't have achieved this but for the outstanding leadership and commitment of Sqn. Ldr. Baldev Singh, Head of Flight Test Centre (Fixed Wing) at HAL. This also created a record in flight-testing at HAL. All eight Jaguar twin-seaters were cleared for delivery by 31 March 2004.

However, there appeared one more hurdle. There was a letter stating that for HAL sales to accrue, the aircraft had to physically move to the customer's identified destination. Since our software was cleared only for Bangalore-based flying, this could not be met. Again, the participating agencies, Air HQs with its wings ASTE and SDI, CEMILAC and DGAQA came out in 'flying colours'! Based on the confidence already generated, this clearance was accorded and the Jaguars flown to Pune. That is how the HAL's sales turnover about Rs. 700 crore was generated in this very first delivery.

Contributions of DARE

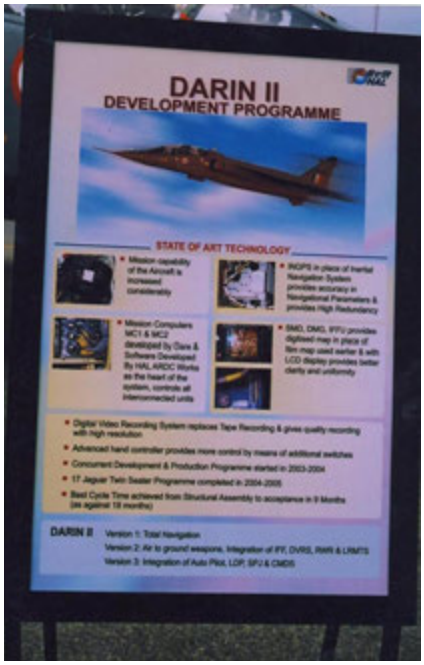
The contribution of DARE who were major partners in the programme merits special mention. DARE was responsible for the Mission Computer (MC) and hardware for ten units were delivered, then development of software for Head-up

Display (HUD) symbology generation and 1553 protocol and device drivers.

All deliverables were completed in record time and as per schedule– a remarkable achievement indeed.

Spin-Offs

The DARIN-II programme resulted in numerous spin-offs. With such expertise generated both in the technical stream and also in project execution, HAL could embark on other upgrade programmes : the software for deployment of weapons tested and proved in this programme could also be used for other projects. The design team had achieved a very high level of motivation and could confidently embark on follow-on programmes. With



such foundations laid for a viable business model, an entirely new Division (Mission Combat Systems R&D Centre) was established by HAL.

Yogesh Kumar

The author would like to gratefully acknowledge the contributions and support given by then Commandant ASTE Air Cdre Anil Chopra (now Air Marshal and AOP) and his team of flight test engineers and pilots (then Gp Capt PP Reddy and Sqn Ldr Harsh Thakur did the first and many subsequent flights). Similarly, SDI gave full support towards development of the software, weapons related algorithms etc.

Active support and encouragement were provided by the top management of HAL, the then Chairman NR Mohanty, Director Design Ashok K Baweja, MD Bangalore Complex AK Saxena and numerous Directors and General Managers who were directly or indirectly associated with the programme. Comprehensive support was provided by certifying agencies (CEMILAC and DGAQA), various DRDO Labs, and CSIR NAL, during execution of the programme. Air HQs always 'held our hand' and gave guidance and encouragement during various crucial stages of the programme.

Last but not the least, my entire team of AR&DC which worked virtually around the clock to make this a success, in particular MS Nadgir, Dr C Subramaniam, PL Vaishampayan, NC Agarwal, SK Velluswamy, NC Vyas, SP Bhattacharya, and many more including technicians and the supporting staff.

Finally, my grateful thanks to AK Sood, former GM HAL and currently Advisor NCAD, who helped me in preparing this article.

[Photos on pages 2-3, 4-5,8-9,10 (lower) by Pushpindar Singh]

Jaguar DARIN II cockpit

Above and below, Jaguar twin-seaters at HAL Bangalore before delivery to the IAF.

Yogesh Kumar, then Director (Light Combat Aircraft), Hindustan Aeronautics Limited receiving the Raksha Mantri's Award for Excellence on 9 June 2006 at New Delhi. Also in the picture are Rao Inderjit Singh, RRM and Mr KP Singh, Secretary for Defence Production.

GILDING THE LILY?

Continuous upgrades of the IAF's Jaguars

The first official flight of the DARIN III prototype (JM255) on 28 November 2012 (see *Vayu VI/2012*) marked an important milestone in the IAF's Jaguar upgrade programme that has seen progressive modifications gradually introduced over a period of nearly 30 years. When the original purchase contract was confirmed in April 1979, the IAF were already aware of the lack of capability afforded by the Marconi Elliot Navigation Attack Weapon Aiming Sub System (NAVWASS) due to be incorporated in their first batch of 40 aircraft supplied direct from British Aerospace at Warton. In India a committee was set in August 1979 in order to manage a future upgrade project that seeked an improvement in the aircraft's capability. Various vendors, including Ferranti, Smiths, Sperry, Marconi and SAGEM were asked to submit proposals that were needed to satisfy the need of Inertial Navigation and Digital Ranging and Attack programme. DARIN I, as this became to be designated, was expected to be developed and fitted to the first of 45 aircraft to be assembled from kits on the Hindustan Aeronautics Ltd (HAL) production line in Bangalore, the first of which was due in 1982.

The first 40 direct supply aircraft from Warton arrived in India between July 1981 and November 1982, enabling Nos.14 and 5 Squadrons at Ambala to re-equip and release back to the UK those on loan from the RAF that first arrived in July 1979. Two of the direct supply single seat aircraft (JS102 and JS103), were to become the DARIN I prototypes and these required some structural modifications and new electrical looms to be fitted in order to permit installation of the new Line Replacement Units (LRUs) . The LRUs had been selected to meet an Air Staff Requirement that called for navigational accuracy after one hour of flight, weapons accuracy, third level redundancy in mission accomplishment parameters and easy replacements of high mean time between failure components. All of these were required to be environmentally suitable for the harsh Indian climate and topography, plus they had to be integrated using the MIL-STD1553B data bus. The LRUs were the SAGEM UNA-82 Inertial Navigation System (INS), Ferranti Combined Map and Electronics Display (COMED), Smiths Type 1301 Head Up Display (HUD) and Weapons Aiming Computer (WAC), Crozet air data computer, SFIM Flight Test Instrument Package, Ferranti Laser Ranger and Marked Target Seeker (LRMTS) and the HAL produced RAM-200 radio Altimeter, ARC-201 radio compass and IFF400 inspection friend or foe system.

The two prototypes of the DARIN I upgrade programme were ferried to Bangalore in 1981 for modification and trials and the first flight of a DARIN I equipped Jaguar took place at ASTE on 17 December 1982. Whilst this development was in progress HAL announced that the batch was to be increased from the original 45 to 76, with the increased numbers to be the first batch made in India from raw materials. The IAF's wish of completing the DARIN I upgrade for the first of the locally produced Jaguars was not achieved with the first production DARIN I example (JS140) flying on 26 March 1985, leaving the first four HAL assembled aircraft (JS136-JS139) being supplied in NAVWASS configuration. Gradually

the DARIN I mod was embedded onto all aircraft leaving the factory after assembly and later manufactured by HAL.

The first squadron with the DARIN I was No.27 at Gorakhpur and after work up at the HAL factory in early 1985, were flown to Jamnagar, where they proceeded to use the co-located firing range, after which their armament results were found to be the best of any Jaguar squadron at the time ! Initial Operational Clearance of the DARIN I was awarded in 1984 followed by full clearance in 1985. After work up they departed to Gorakhpur with nine aircraft in August of the same year and were followed by No.16 Squadron, which converted in October 1986. The batch 2 aircraft were supplied with an uprated Rolls Royce Adour 811 in place of the originally supplied Adour 804E and also manufactured in the UK and delivered in 1986. After re-assembly, JM251 flew for the first time in December 1986 and the designated squadron, No. 6 ('Dragons'), received their first of seven aircraft starting 31 March 1987 from the HAL production line (of Batch 2). The aircraft were equipped to DARIN I standard and used the Ferranti COMED as the cockpit radar display. They worked up at Bangalore for a further two months before moving to Poona, later receiving another four aircraft from batch 3 along with some standard DARIN I IS and IT.

Between 1982 and 1998 there had been several improvements in the Jaguar fleet not associated with the DARIN I upgrade. These were, in the main, replacement of the Adour 804E of batch 1 NAVWASS aircraft with Adour 811s, the

The first Jaguar DARIN III aircraft (JM 255) before test flight Bangalore's HAL airport (photo: HAL).

included some HAL-built avionics and instruments such as the radio altimeter, air direction finder and artificial horizon.

The IAF also had a requirement to operate the Jaguar in the maritime strike role and had procured some Thomson CSF Agave radar units which were to have been originally fitted in the direct supply aircraft. Fitting the new radar required a re-design of the nose cone and HAL initially did not have the required jigs and fixtures needed for the conversion, nor they did not want to interrupt the flow of DARIN I aircraft on the line and as a consequence the first aircraft (JM251) was re-installation of the air to air refuelling system, the integration of Tracor chaff dispensers and the application of radar absorbent paint to the engine intakes and leading edges that reduced radar cross section profile by 70%.

News of a mid life upgrade for the entire Jaguar fleet surfaced in August 1998 following a seminar in Bangalore chaired by HAL's Aircraft Research and Design Centre (ARDC). The brief was to upgrade the avionics on the first direct supply aircraft and to include additional improved LRUs for the DARIN I aircraft all linked via the MIL-STD1553 data bus. The latter would allow the introduction of new avionics with the minimum hardware change. At this time newer generations of combat aircraft were using a ring laser gyro (RLG) – based inertial navigation system (INS) that had distinct advantages because of its weight, improved performance and reliability. Newer combat aircraft also had improved navigational accuracy by interfacing a global positioning system with the RLG/INS. Thi upgrade project to be known as DARIN II began in September 2002 and it was to extend the life of the Jaguar by another 20 years. The system was designed to perform the basic functions of navigation, guidance, attack, electronic warfare management and bus control via inputs such as altitude, position and air data sensors. After processing, the information was to be sent to the pilot quicker and more accurately via the multi functioning displays, enabling him to reduce his workload and facilitating mission success. The upgrade of 68 aircraft was to include 30 basic NAVWASS aircraft from batch 1 and 38 from the proposed factory new batches of 4 and 5, the latter two batches having been announced on 8 December 1999.

The DARIN II programme was to include numerous upgrades consisting of 30 new LRUs, notable of which were a SAGEM RLG incorporating Thales Sigma Global Positioning System (GPS), a Defence Avionics Research Establishment (DARE) MC1/MC2 dual redundancy mission computer, a Sextant MFD665, 6''x 6'' smart Multi Function Display (MFD), an ELBIT EL-OP head up display, control panel and digital map generator, a Sextant autopilot and hands on throttle and stick (HOTAS). HAL were to provide the TACAN IFF1410 transponder, INCOM-1201A secured communications radio, VUC-201A VHF radio and COM-1150A UHF radio. Other improvements included carbon brakes, an onboard oxygen generation system, a new brake parachute and high resolution video recording. External changes to the fuselage were required to accommodate the tail-mounted Bharat Electronics Tarang Mk2 Radar Warning Receiver (RWR), an ELTA fire control radar in a re-profiled nose and the introduction of an air to air refuelling light in the starboard air intake. The Jaguar IT under DARIN II did not require the LRMTS and therefore

it retained its pointed nose, however under the upgrade its only Aden cannon on the starboard side was removed and recess covered over enabling it to accommodate the ELTA Self Protection Jammer (SPJ), EL/M8022 internally in the space. This modification was also carried out on DARIN II single-seat aircraft, however with the retention of the port side Aden cannon. [see article in this issue].

Owing to the sheer size of the programmeme, all of the above were to be gradually introduced over a period of 2003-2009. Some aircraft were sent to squadrons with only partial DARIN II modification having been completed and most only reached full DARIN II status with the introduction of the ELTA fire control radar in 2009. The first DARIN II aircraft flew on 29 September 2003 followed by initial operational clearance of the IS aircraft produced on the HAL line (batch 5) by September 2006 and full operational clearance on NAVWASS conversions by April 2007.

The DARIN II entered service with No. 5 and 14 Squadrons at Ambala and the extra airframes coming off the line enabled a sixth squadron , No. 224 to stand up at Jamnager in 2008. With the better weather conditions in Jamnagar, No.224 Squadron became the Jaguar Operational Flying Training Unit (JOFTU) and had one of their two seat trainer aircraft specially converted with a fixed in flight refuelling probe. Co-located at Jamnagar were No.6 Squadron that had moved in from Pune in 2007. Previously, in June 2004, the remaining 10 Jaguar IMs of No.6 Squadron had seen the original Agave radar been replaced by the Elta 2032 maritime surveillance radar, enabling it to use the AGM-84L Harpoon in the anti shipping role. Certain modifications from the DARIN II programme had also been embodied and they had received three DARIN equipped Jaguar ITs.

In 2008 a further upgrade was mooted for the Jaguar and a mock up cockpit was displayed at Aero India in 2009. This upgrade to be known as DARIN III was to be jointly developed by HAL and ELBIT using a company set up by the pair in 2007 and known as HALBIT. Central to the DARIN III upgrade are a series of three MFDs manufactured by Samtel-Thales Avionics that were based on a previous successful bid to upgrade F-5 aircraft of the Brazilian Air Force. The two 8" x 6" and one 5" x 5" displays facilitated reduced cockpit clutter by replacing analogue engine and fuel instruments in the control panel as well as the ELBIT digital map generator. The core avionics computer is an Open Systems Architecture Mission Computer (OSAMC) developed by DARE and produced by a joint Indo-USA venture involving HAL, Edge Tech India and Edgewood Ventures LLC. A new defensive aids suite jointly developed by the Defence Research Development Organisation (DRDO) and Cassidian will be introduced to replace the 'indifferent' Tarang system. This will include a radar and laser warning receiver, full multi spectrum detection capable missile approach system, electronic warfare jamming pod and fibre optic towed decoy. Other cockpit improvements include a Hand on Throttle and Stick (HOTAS), an auto pilot and EFIS flight instruments. Also the aircraft's air conditioning was to be improved in order to meet equipment cooling requirements.

The contract was awarded to HAL in 2010 and was to be for 58 aircraft that included the remaining DARIN I airframes. The most obvious part of the DARIN III upgrade was inclusion of a radar unit in the nose to replace the existing LRMTS. Much speculation had surfaced as to what type of radar this will be, and this has probably been confirmed

Jaguar DARIN I's is of No. 27 Squadron

Jaguar at an IAF fighter base

Batch	Source and Mod State	Serials	Sub Type	Date of Delivery	Quantity	Total
1	Direct Supply NAVWASS	JS101-135 JT051-055 JM251	Jaguar IS Jaguar IT Jaguar IM	1981-1982 1	35 5 1	40 1
2	HAL Assembled and Manufactured DARIN I	JS136-194 JT056-065 JM252-258	Jaguar IS Jaguar IT Jaguar IM	1983-1998	59 10 7	76
3	HAL Manufactured DARIN I	JS195-205 JM259-262	Jaguar IS Jaguar IM	1996-2000	11 4	15
4	HAL Manufactured DARIN II	JT066-082	Jaguar IT	2005-07	17	17
5	HAL Manufactured DARIN II	JS206-225	Jaguar IS	2006-09	20	20

by the fact that the first official DARIN III prototype as mentioned above turned out to be Jaguar IM (JM255) equipped with the Elta 2032 radar or a version of it. This radar would necessitate all DARIN III conversions to require a re-profiled nose similar to the Jaguar IM. Also the radar would be multi mode to meet its prime role of ground attack and to enable partial air to air ability for short range missiles. This new short range air to air capability, together the DASH 4 helmet mounted sight will enable to DARIN III Jaguars in the future to carry a short range missile for air defence, 100 of which have been requested by the IAF. This selection will probably be made from the Rafael Python 5, Raytheon AIM9X, Diehl IRIS T or MBDA AIM-132 ASRAAM. The enhanced weapons carrying capability will in the future allow DARIN III Jaguars to carry a variety of new generation weapons including precision guided missiles, bombs and various electronic pods. These will include the GPS guided CBU-105 wind corrected munitions dispenser which was order by the IAF in December 2010, the Rafael Lightning Laser Designator Pod already in service with the IAF and a 'to be determined' anti radiation missile for attacking enemy ground radars. Since 2008 Raytheon had been testing a Munitions Control Unit (MCU) on the Jaguar and a contract for this was signed in 2011. This MCU will enable the IAF to integrate modern weaponry onto legacy aircraft including the Jaguar with the minimum amount of hardware changes.

And then, the cherry on the cake ! The missing piece in the Jaguar's upgrade story is replacement of the aircraft's engine. The ability to operate at hot and high locations whilst fully loaded has impaired the Jaguar's performance in the IAF. A bidding process was launched in 2009, followed in November 2010 by a Request for Proposal and two companies were short listed, Rolls Royce with the Adour 821 and Honeywell F125IN. In March 2011, Rolls Royce withdrew from the bidding process partly because of the IAF's desire to have new engines rather than uprated powerplants. This withdrawal effectively closed the bidding process and resulted in the Indian Ministry of Defence issuing a RFP based on a single vendor basis in June 2012.

Phil Camp & Simon Watson

FRITZ OF THE FUTURE

Precision Guided Munitions (PGMs)

Sequence of an IAF Jaguar of No.6 Squadron dropping LGB against ship target .

Depending on one's vintage, we think of PGMs either as weapons of the First Gulf (1991), or even earlier, of the second Indochina (1972) wars. Their origin lies, however, in a much older generation, when the Luftwaffe's Gruppe III of *Kampfgeschwader* 100 *Wiking* (Viking), or *III/KG 100*, sank the Italian Navy's flagship using three antiship guided glide bombs, popularly referred to as 'Fritz X'. This was on the day after Italy's surrender to the Allies on 8 September 1943, and the Navy fleet commander ordered to sail out from La Speiza for Tunisia. He led two battleships, three cruisers, and eight destroyers. To prevent this fleet from joining the allies, six Dornier Do-217s with one 'Fritz' each attacked the two battleships. One, though damaged, reached Malta. The other, *Roma* (46,000-tons), took two hits and sank when her magazines exploded. More than 90% of the crew and their admiral perished. Of course by today's standards, the 'Fritz' was a crude weapon, but interestingly was still launched from outside the range of Italian AA batteries. 'Fritz' did not have a self-homing capability but its control wings were manipulated by radio control.

Now fast forward to the Second Indochina war. The tendency is to think of the Thanh Hoa bridge across the Song Be River as the first success of US guided bombs. But as early as 1967, for example, US Navy A-6 Intruders from the carrier *Bon Homme Richard* had destroyed the Hanoi power plant using Walleye AGM-62 TV-directed bombs. (The North Vietnamese, who were astonishingly good at reconstruction, repaired the plant and it was on a re-attack mission that Lt. Cdr. John McCain III was shot down in his A-4 flying off the USS *Oriskany*.)

The ThanhHoa Bridge is not an epic on the scale of the RAF No. 617 Squadron's attack against the Ruhr dams, or the USAAF's attacks against the Ploesti oil fields, but outside of World War II it is the interdiction battle of note. The bridge was put under continuous attack without result from 1965 to 1968. Then the Johnson bombing pause intervened. In

1972, attacks resumed and in a series of three attacks using LGBs and TV-guided bombs, the bridge was destroyed. Some 800 missions had been flown against it since 1965, and contrary to popular memory, the bridge was hit repeatedly, including by guided Bullpups used in 1965. But the bridge was so tough, that it could not be destroyed and invariably the North Vietnamese would repair damage. When it was finally demolished, the means were 2000-lb PGMs.

The first Gulf War imprinted itself on public memory as 'the PGM war' because of the extraordinary visuals released by the US military. By now air-delivered PGMs had at last, become point-and-shoot weapons of great precision. Of course, PGMs were used in large quantities by all the Services. The US Navy, for example, employed the Tomahawk missile, which could impact within 10-metre accuracy after travelling 2000-kilometers at low-level. The US Army used a variety of anti-tank missiles launched from both ground and air. Nonetheless, an iconic picture of the First Gulf War remains that of the man desperately racing across a bridge as seen from the TV-guidance eye of a PGM as it homes in. He seems to make it to safety, but modern 2000-lb bombs have such a wide destructive blast radius against humans in the open it is unclear if he survived. After the 'First Gulf', war had virtually become a video game, watched in our living rooms.

IAI's Lahat: laser homing anti armour missile

PGMs and the air force

It is useful to keep in mind that even without PGMs, accuracy in air-ground bombing increased by three orders of magnitude, or a thousand times, as air forces went from dumb aircraft/dumb bombs to smart aircraft/dumb bombs. In World War II, hitting a target 20-meters by 50-meters with 2000-lb bombs had 96% probability. This War required an average of 9000 bombs and 3000 aircraft. Just 25-years later, in the Vietnam War the numbers fell to 176 bombs dropped by 44 aircraft. By the 'First Gulf', accuracy at low-level had improved to 10-meters CEP and at medium altitude to, 50-meters. In the latter case, perhaps two aircraft with eight bombs might be required.

With PGMs, however, a single aircraft and a single bomb suffice to hit the hypothetical target, making the smart aircraft/smart bomb ten thousand times as accurate as World War II bombers. This figure, nonetheless, understates the accuracy gain. The single F-15 with a single 2000-pound PGM can equally well hit a target 13-meters square, or four times smaller than the 20 x 33-meter target as above, whereas presumably about 10 aircraft and 40 bombs with 'Persian Gulf' accuracy would be needed. That gives an improvement 40,000-times over that of World War II.

Then consider the human cost. The USAAF lost 286 bombers in the Ploesti campaign (the British lost another 38). US aircrew losses were 2860 killed or captured. Five heavy bombardment groups (72 aircraft each at full strength) participated in the main 1943 attack alone. Today a single B-2 could destroy Ploesti using satellite guided bombs, while staying well out of range of ground missiles/guns and virtually invisible to enemy fighters. Ploesti had nine refineries; it is necessary only to hit a vital unit of a refinery, say the cracker. The B-2 carries 16 x 2000-lb PGMs. Or 20 Tomahawks could do the job with no risk whatsoever

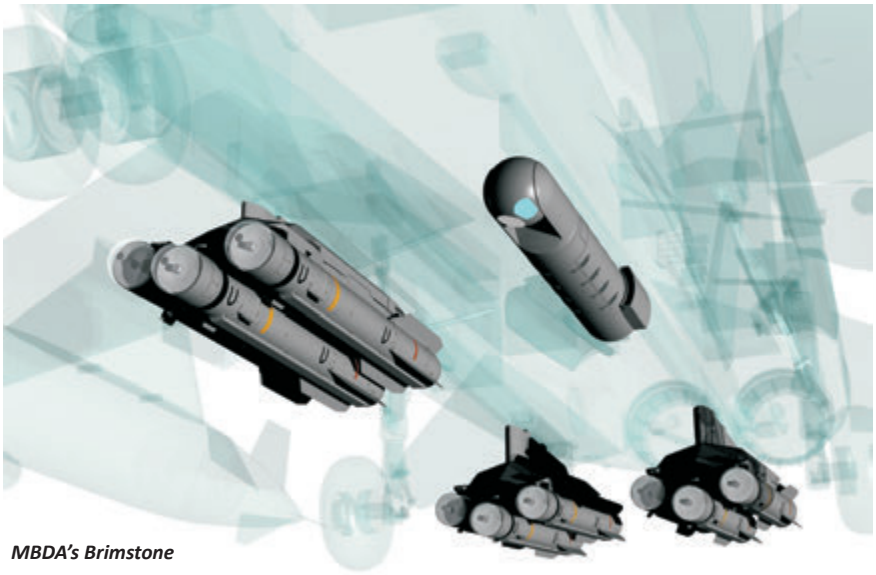
Rafael's Spike-ER

TEXTRON INDIA

to the operator. The Ploesti campaign was spread over months. Because of pre-stored global imagery, the B-2 crew would need at most a few hours of planning before launching. Indeed, the B-2 could launch without the crew having any idea of their target: instructions and target conditions would be continuously delivered while in-flight.

Does this mean that compared to 'First Gulf' aircraft levels, we can reduce the number by 100? Not exactly. Take the Indian Air Force's hypothetical force level of 800 combat aircraft in 36 squadrons including trainers and reserves. Obviously four fighters, say T.50 FGFAs, are not going to perform the missions that 100 Mirage 2000/Jaguar/MiG-27s do presently. Attacking fixed targets is just one air force mission. Escort, ground support, air defence, reconnaissance are the other important ones.

Rather than permitting a small number of aircraft to be operated, PGMs can decimate those which earlier would have been unassailable targets. To paraphrase the famous C. Northcote Parkinson, "target sets rise to fill strike capacity". In the Indian sub-continental context, attacking bridges across the Indus River would once have been a formidable exercise, requiring the diversion of a large number of aircraft and sorties, with the prospect of severe losses, with little assurance of destroying the bridges. With PGMs the principle becomes "if you can reach it, you can destroy it". A strike package of perhaps 16 aircraft (8 strike and 8 escort) would likely down a bridge in one mission-as cost effective as it gets.



MBDA's Brimstone

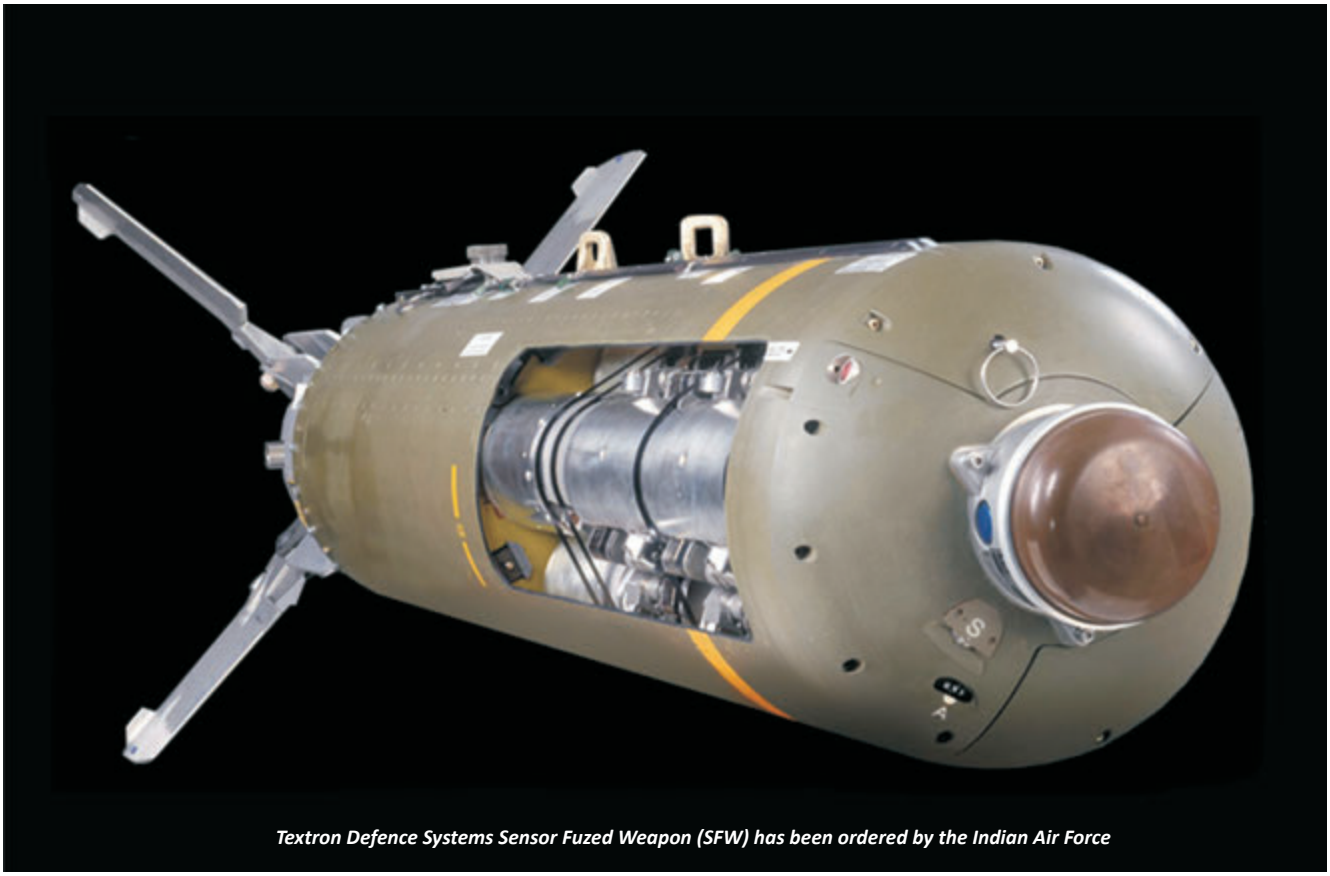
Of course, PGMs are double edged as Pakistan has them too. While the PAF has fewer aircraft, its PGMs could cause great damage, for example, by attacking bridges across the Jamuna or those across the Chenab, Beas, and Sutlej rivers, which could materially affect the course of a ground war. In the mountains, PGMs can obliterate vital targets such as mountain passes and road bridges, crippling both strategic and tactical movement.

Raytheon's Javelin

PGMs and ground forces

An area where PGMs have not had dramatic effect is against land targets. Every successive generation of anti-tank weapons has been claimed as ending tank supremacy on the battlefield, but this has not happened or is unlikely to happen any time soon. The main reason is that further armouring tanks is relatively easy. The legendary 30-ton M-4 Sherman had 75mm-100mm armour protection. The M-1 Abrams weighs 60-tons and can defeat any tank round and most ATGMs as well. The AGM-65 Maverick (air-ground missile), is an entirely different matter: it weighs 300-kg and has a 57-kg warhead which can blow apart any MBT, no matter how heavily armoured. End of the tank? No, because instead of only passive defence such as reactive armour, active tank defences have been developed. Generally, these fire 'buckshot' at an incoming missile or RPG, at very close range. Doubtless a counter to these active defence systems will soon be developed and laser defences are on their way as are electronic countermeasures to interfere with missile homing mechanisms.

And sometimes PGMs do not work as expected. An example is the Seek and Destroy Radar Assisted Munition (SADRAM), a 1980s era programme that eventually failed. A 155mm artillery shell was to have 2 rounds, while an MLRS rocket carries six. Once fired over general vicinity of the target, the rounds would eject, each autonomously to



Textron Defence Systems Sensor Fuzed Weapon (SFW) has been ordered by the Indian Air Force

straddle an area of 150-metres diameter, or approximately one hectare, and home onto target once detected. If not, the round would deactivate itself when it reached the ground so as not to pose a threat to advancing own troops. A 6-launcher MLRS battery could, in theory, destroy 432 targets within a four-square-kilometer area. This should suffice, in practice, to destroy a tank regiment, a self-propelled artillery battalion or a mechanised infantry battalion; in other words, have the same effect as a large tactical nuclear weapon. An MLRS battalion of 18 launchers, firing two or three 12-rocket salvos for each launcher, would suffice to destroy an Armoured or Mechanised Division.

Nonetheless, the SADRAM was never sufficiently cost-effective for production and was soon overtaken by anti-armour cluster bombs such as the CBU-97, 512 rounds of which the US sold to India in 2010 for employment with the IAF's Jaguars. Such cluster bombs contain, for example, 40 sub-munitions within a 454-kg package, and can cover a 1.5-square-kilometer area. Like all modern cluster weapons, the sub-munitions deactivate if they do not find a target. One type, the Skeet, even has a back-up in case the primary deactivation fails.

PGMs and naval forces

At sea, PGMs made their first appearance in World War II, with the development of homing torpedoes (acoustic, magnetic, and wake). By the late 1950s, the Swedes (Rb04, active radar) and Soviets (P15 Styx, active radar/IR) deployed PGM anti-ship missiles at sea. While the Israeli destroyer *Eliat* was the first warship sunk by anti-ship missiles (1967), four years later the Indian Navy used P-15s launched from *Osa* missile boats to attack Karachi, inflicting major losses on Pakistan Navy warships and merchantmen in the harbour. Just two years later the Israelis used countermeasures to neutralise Syrian and Egyptian missiles in the October War and anti-ship missiles to attain sea supremacy. The 1982 Falklands War raised alarms in Western navies when Argentine A-4 Skyhawks flying at maximum range sank two British task force ships and damaged another. The seeming helplessness of the targets underscored vulnerability of surface warships to the new weapons. Several ships were hit by missiles in the 1987-88 Gulf Tanker War.

Interestingly, the same feature making ships vulnerable to PGMs also makes them easier to defend. US Navy carriers, for example, are 333-meters long and can hardly be 'stealthy'. Conversely, these can deploy a large number of defensive weapons. Aside from the EW weapons, surface ships carry long range missiles for interception of aircraft and cruise missiles plus short-range missiles and Gatling guns with intense rates of fire between 3000 and 6000 rounds per minute. An *Aegis* cruiser, for example, has 122 missile rounds, 2x25mm Bushmaster cannon, and 2xPhalanx systems 4x12.7mm machine guns. It also has 2x5" guns, but one is unclear on what anti-missile capability these really have. It needs noting that today's land system defensive measures include systems designed to shoot down rockets, artillery shells, and mortar bombs, which can be easily adapted for shipboard use.

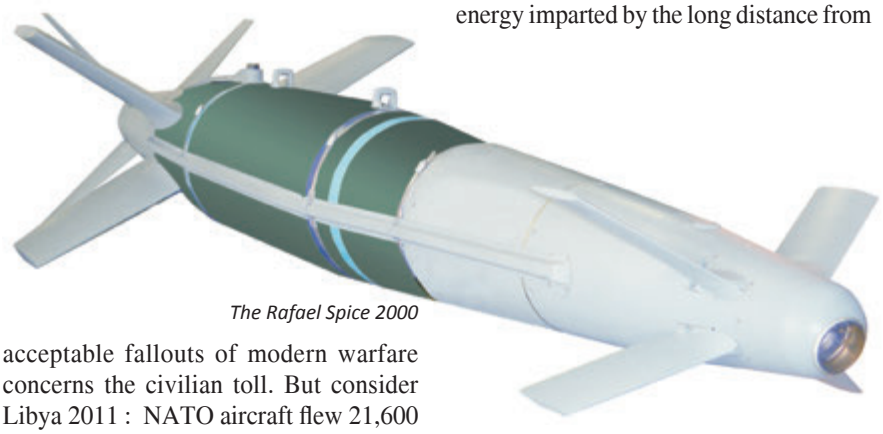
Beyond all this is the shipboard laser which is now reaching deployment stage. This will provide a near unlimited number of shots, and the system does not care how fast the incoming target is. Because

the laser beam travels at near light-speed, there is no need to compute intercept solutions.

Obviously lasers are not the ultimate defence against PGMs. For example, anti-ship missiles can be 'hardened', but it is not difficult to scale up shipboard lasers to meet such measures. Moreover, simply 'frying' the sensors on incoming anti-ship missiles renders them useless.

PGMs and collateral damage

Certainly, the real revolution brought about by PGMs, is, in the order of magnitude, reduction of collateral and civilian casualties. One of the least acceptable fallouts of modern warfare concerns the civilian toll. But consider Libya 2011 : NATO aircraft flew 21,600 sorties of which 9,700 were for strike. One thousand AFVs and artillery pieces were destroyed. Yet the 'Human Rights Watch' has been able to come up with 'just' 72 civilians killed based on their investigations.



The Rafael Spice 2000

Nonetheless, this is an incredibly low figure given intensity of the air campaign, where the majority of strikes were conducted with PGMs. However, it was not just the PGMs, as the enormous increase in reconnaissance capability meant that up to the time of weapons release, if civilians were seen within collateral damage range of the target, the strike could well be cancelled.

On the other extreme were the horrendous civilian losses in nuclear attack against 'military facilities' at Hiroshima and Nagasaki. About 150,000 persons, mainly civilians perished. This need never happen again.

Future PGMs

In contemporary warfare, PGM capability is taken for granted. Our minds no longer boggle at the spectre of missile-armed UAVs hunting and eliminating individuals in vehicles on a highway; the idea that a Hellfire missile can be directed through the window of a room to kill those within no longer astonishes. And yet all this is nothing compared to what is yet to come. There are systems under development that can loiter in the air for hours, soon to be days, virtually 'whispering' above, akin to 'dozing' robots. A few signals and the drone 'wakes up', finds its target, kills, and returns to taking a 'nap'. Another system possibly to be used on the super-secret X-37 orbital vehicle, can remain in orbit for a year or more, can reach any part of the world in 30-minutes to direct tungsten rods against a target. The kinetic energy imparted by the long distance from space and the precision of today's satellite targeting systems, eliminates the need for warheads. These rods can penetrate 60+-meters of concrete, to hit with zero collateral damage.

PGM development continues at a revolutionary, rather than evolutionary, pace. Some new developments include kits to turn dumb artillery shells into smart ones, just as happened with dumb bombs. This could lead to reductions in artillery units and certainly will reduce ammunition loads. Then, smart 0.50-caliber sniper bullets can eliminate the need to "walk-up" sniper rounds and reduce the possibility of the enemy realising he is under fire. Equally, counter-sniper systems are under development. Then current satellite and signal guided PGMs are vulnerable to disruption of their sensors and so new systems using inertial guidance are under development for both shells and bombs.

The world of military robots and PGMs is inextricably linked. A system under development handles underwater threats. Stealthy, autonomous, long-period weapons can be released in contested water, such as the Straits of Hormuz, and can be directed to either hide or to skulk. As soon as a potential target like a mine is detected, the weapon will home in, 'sniff' the threat, and take necessary action such as disabling the mine without exploding it. The party doing the mining will be unaware that its mine is no longer operational.

It is possible to envisage attack submarines with stealthy, long-loiter torpedoes, released at need to form a screen. The torpedoes can attack after detecting threats, or recalled for recharging their batteries. Such a system, of course, depends equally on major battery advances, but these are also underway.

A system like the X-37 which is stealthy, can be put into orbit with a load of tiny, stealthy, self-propelled guided mines. The X-37 orbital vehicle can quietly release these mines and have them self-attached to satellites for activation in wartime. Losing dozens or even hundreds of critical satellites could prove devastating. The counter to this can be very cheap, rapid launch satellites, fired into orbit using – perhaps – air-to-air missiles, which is what the US is presently working on.

Implications for India

The Indian armed forces have made a start for incorporating PGMs . Most advanced is the Indian Navy, by virtue that most naval weapons today are in any case precision-guided: anti-ship, land-attack, anti-aircraft, and anti-submarine. An obvious next step are precision guided-shells for shore bombardment, particularly important in the context of amphibious warfare.

The Army has PGMs in the form of anti-tank missiles, but its experience with smart artillery and tank ammunition has been mixed. The problem has been performance and availability from Russia. The Army will soon enough have to decide what is more important: relatively inexpensive Russian weapons whose performance is uncertain, compounded by poor after-sales support from the manufacturer, or more expensive but more reliable western systems.

The Army is heading in the right direction by continuing to increase its UAV inventory : in fact, UAVs are the

flip side of PGMs, because the target must first be acquired before destroying it. However, a massive increase in UAVs at all levels – Corps, Division, Brigade, Battalion, Company, and even Platoon is required. It is particularly important for the Army to use PGMs/ UAVs to address the problem of "the last 100-meters", when the infantry must leave its cover and charge into the unknown. India's problems with land mines are well known, which result in unacceptable casualties both in laying and then removing them. Smart mines launched from aircraft, helicopters and ground vehicles, that can rapidly create barriers against advancing armour and cover flanks in the attack, are needed in large numbers.

The Indian Air Force has always trained for the interdiction mission as, next to air defence, the IAF's rationale for its existence has been to attack an enemy deep in the heartland. With increased use of PGMs, the IAF can certainly achieve dramatic results during interdiction attacks and can also carry out ground support without exposing aircraft to ground based defences as anti-troop and anti-armour area weapons can be launched from safe distances. But all this requires large numbers of UAVs, in the hundreds and PGMs, in the tens of thousands.

Ultimately there is no choice but for India but to allocate considerable funding on the development and procurement of PGMs. This means a regime in which development failure is not an option, so that we could inevitably end up buying 'foreign', and that too, years after an indigenous system has been 'promised' to the Services.

In the late 1980s, General K. Sundarji presciently observed that Pakistan was no longer a danger – it was China to be guarded against. With China's GDP already quadruple that of India's – in 1980 it was about the same – it will be the mid-to-late 2030s before India's GDP starts catching with China's. Thus far India's response to China has been quantity, an example being the continued expansion of India's mountain forces even as China continues to shrink theirs in Tibet. Some of China's Armies (equivalent to India's Corps) are actually now down to 3-6 Brigades. Conversely, China has striven to enhance the quality of its forces as a direct counter to numbers.

Raytheon AGM-154 dropped from a F-16

Still, there is a danger that we are so infatuated with technology per se that we forget numbers are also critical, something the US has experienced in Iraq and Afghanistan. But there has to be a balance: both numbers and technology are required. India is on the correct track with PGMs, but this is only a start. Far more needs to be done in the 5–year plans till 2027, particularly in context of the northern neighbour.

Ravi Rikhye

The Shadow Of Fear

Unmanned Aerial Vehicles over South Asia

Unmanned Aerial Vehicles (UAVs) – or drones – have become more vital than ever in low intensity conflicts and the "fight against terror." Their effectiveness can be determined by the results of US operations against terrorist targets in Afghanistan and Pakistan, where drones have cast a shadow of fear on an enemy that once roamed freely. So effective are these new weapon systems that they have become the weapon of choice for the US administration in its war against this elusive enemy.

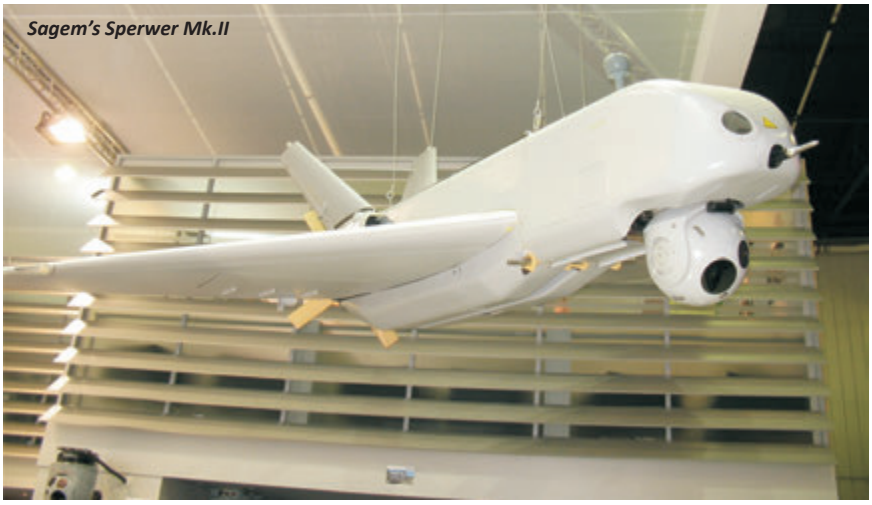
As everyone knows, UAVs are unpiloted aircraft that are remote controlled, but what some don't know is that some of these are equipped with cutting edge equipment and weapon systems whose primary role is to find, track and obliterate security threats, with minimum collateral damage. So effective has the CIA-directed drone war against al Qaeda and Taliban been over the past few years, that most of their top leaders are now eliminated, their adherents forced to work in small groups (often without an experienced leader), without any form of modern communication, nor travel in public buses and constantly moving from one location to another.

Life has 'in fact' become hell on earth for them !

Deployment of UAVs

UAVs were first known to the public during the conflict in Bosnia and Kosovo in the 1990s where US Predator UAVs were used to collected intelligence and track refugees. These operations also prompted the next logical step in their development - arming these platforms and converting them into becoming the next generation of 'killing machines'.

The effectiveness of UAVs was dramatically felt during the US intervention in the Gulf and then in Afghanistan. Now, the use of drones has rapidly transformed



Sagem's Sperwer Mk.II

IAI Malat's Heron MALE UAV has proven itself in operations

the way the US goes to war. Troops at the FEBA receive real-time data from a drone which enables them to view the landscape in every direction and take informed decisions that would dramatically change outcome of the battle. Drones have in fact radically altered the way intelligence is gathered and has transformed the CIA from being a civilian intelligence-gathering agency into a full-fledged military operator.

But the implication of drones go far beyond a single combat unit or civilian agency. On a broader scale, the remote-control nature of unmanned missions enables politicians to wage war while claiming not being at war, as the United States is currently carrying out in Pakistan. What is more, the Pentagon and the CIA can now launch military strikes or order 'assassinations' without putting a single boot on the ground – or without worrying about a public backlash over US soldiers coming home in 'body bags'.

Some notable 'kills' of the drone war include that of Ilyas Kashmiri, a dreaded Pakistani militant, Anwar al-Awlaki the radical American-born cleric, Atiyah abd al Rahman and Abd al-Rahman al-Yemeni from the Al Qaeda, Mohammed al-Faateh, Abdullah aka Nadeem from the Haqqani network and Hazrat Ali, Sher Ali and Umar Wazir from the Maulvi Nazir. The Central Intelligence Agency is credited with having collected and collated information on Osama bin Laden's compound in Abbottabad from a drone.

The rugged mountainous terrain of Afghanistan, scene of bitter battles between US and ISAS forces against the al Qaeda and Taliban (photo by Jaspreet Singh).

In Libya, US President Obama had authorised the use of drones earlier on in the NATO-led air campaign against Muammar el-Qaddafi's forces, leading to his capture and subsequent end.

UAVs over Afghanistan and Pakistan

In the skies above Afghanistan, Unmanned Aerial Vehicles (UAVs) are providing ISAF forces with a significant advantage over their adversaries. UAVs are flying more than 30 missions a day in this region, providing video surveillance, fire support and enhanced combat capability.

The killer drone programme in Pakistan is being recognised by counter-terrorism officials as "a resounding success", eliminating key terrorists and throwing their operations into disarray. Of course the programme has generated much public anger in Pakistan and some counter-insurgency experts speculate on whether it does more harm than good. While the Pakistan military has done its best to oppose the drone campaign as relations with the United States soured after the killing of Osama bin Laden in May 2011, for President Obama, continuing with the drone war has been worth any fall outs.

Most ISAF and US forces in Afghanistan increasingly rely on drones as an integral part of their armoury. The US with their Predator UAVs, the Royal Air Force's Reaper, the Spanish Searcher 2, the French Sperwer and DRAC UAVs and the Australian and German Israeli-supplied Heron 1 UAVs have played a crucial role for ground forces and have been used as 'eyes in the sky' for monitoring their targets in Afghanistan. Equipped with an array of hi-tech sensors, these UAVs have been performing a number of tasks in support of ground units, from gathering pre-raid intelligence on target compounds to providing surveillance for routine patrols and supply convoys.

With the imminent withdrawal of US forces from Afghanistan in 2014, the US is placing even more emphasis on drones which will be deployed to support the Afghan National Army with intelligence, surveillance as well as attack functions.

Homeland Security

Outside of conventional military forces, a frequent yet but largely unknown UAV operator is the US Customs and Border Protection (US CBP), an agency of the federal Department of Homeland Security. The US Customs have expanded their use of unmanned aerial surveillance (UAS) and if the new proposed laws are passed, one would have UAVs across large parts of the US skies.

UAVs have been credited with helping to seize over 20 tons of illicit drugs and catching over 7,500 people engaged in illegal activity along the US border since late 2005. The programme's success is not measured by drug interception or border-crosser apprehensions alone, but in assisting emergency and disaster response efforts.

Aerial surveillance of large areas is made possible with low cost UAV systems. Surveillance applications include livestock monitoring, wildfire mapping, pipeline security, search and rescue, medical evacuation, geophysical surveys, home security, road patrol and anti-piracy.

Indian Navy's IAI Malat Heron UAV

IAI MALAT

Drone Operators – the Trauma Factor

A drone operator : this is only a representative image (photo from Wikipedia)

The navigator takes another look at the target area : a flat roofed mud house, with a shed nearby a home for goats. The navigator receives the order to fire. He marks the roof of the house with a laser. Next to him, the pilot pulls a trigger that launches a Hellfire missile. Time to impact: 16 seconds. As the moments tick by, the navigator watches. He has the ability to divert the missile from the target for nine seconds after launch. Nothing happens for 13 seconds. Then a child walks out around the corner of the mud house. Three seconds later, the house, the shed and the child are gone.

The pilot and the navigator are halfway across the world from their target in Afghanistan, sitting in a room in New Mexico. The craft they are handling is a Predator drone, the US weapon of choice in its Afghan war.

Under President Barack Obama, the use of military drones to conduct targeted assassinations against terrorists has surged. This year alone, more than 300 drone strikes have been conducted, killing around 2,500 people. And while the US administration claims drone attacks are accurate, the Centre for Research on Globalization, a Canadian think-tank, estimates that attacks authorised by Obama have killed 800 civilians and just 22 al Qaeda operatives.

In August 2011,the American Bureau of Investigative Journalism estimated that 168 children had been killed by drone attacks in Pakistan since the beginning of the war. The American response as demonstrated by a US military quote in the Military Times was to label children as "legitimate targets."

In *Spiegel Online*, Nicola Abe profiles and contrasts two of America's drone warriors. The first is the navigator in New Mexico, a 20-something called Brandon Bryant. Bryant has completed 6,000 hours operating drones in his six-year stint with the US Air Force. In that time, he says, "I saw men, women and children die I never thought I would kill that many people. In fact, I thought I couldn't kill anyone at all".

Bryant's first missile killed two men, and left a third in mortal agony. The man's leg was missing and he was holding his hands over the stump as his blood flowed onto the ground for two long minutes. The incident left Bryant weeping on his drive back home. He broke up with his girlfriend, as the couple could not handle the stress the job put on him.

By contrast, Major Vanessa Meyer has no such issues. The 34-year-old Meyer was so dedicated that she was flying her drones in the ninth month of her pregnancy, her stomach pressing against the keyboard. Meyer enjoyed the adrenaline rush, while Bryant quit the air force after he found himself asking "Which ******** is going to die today" ? .

Sourced from : spiegel.de; policymic.com; wired.com

India's use of UAVs

One of the first UAV systems to be used by police forces in India was the little known *Golden Hawk*, developed by the Defence Research & Development Organisation (DRDO). Following an official roll-out with Chandigarh Police, and training of specialist police teams in operating the new systems, these mini-drones were used operationally to monitor rallies and marches, providing a broader view for law enforcement personnel and thereby improving situational understanding.

The *Golden Hawk* runs on an electric battery and is equipped with a camera fitted beneath the craft. The aircraft has a limited operational range of 2 km and can take video from an altitude of 80-100 metres, flies for some thirty minutes before returning to station with the recorded footage.

Other developments by the DRDO include the rotary-wing UAV *Netra* which will take off vertically and land, as well as hover. The system was recently tested in Chhattisgarh to evaluate its utility in combating the Maoist insurgency in these areas. DRDO believes this lightweight hovering platform is also likely to see widespread use with police forces. The *Nishant* UAV, on the other hand, is designed for tactical intelligence gathering, reconnaissance, surveillance and target designation, is expected to be inducted into service with the Indian Army.

The *Rustom* series of UAVs are still at the early stages of testing, but are expected to complement, and in some cases replace, the Israeli-made UAVs currently in service.

IAI ELTA

Elbit has a large number of UAVs on offer to India and other international customers.

In early 2012, the *Lakshya-II*, an advanced version of DRDO's Pilotless Target Aircraft (PTA) was demonstrated. The entire flight was pre-programmed and "was totally successful. It demonstrated various technologies and sub-systems including software correction to auto rudder scheme done to prevent loss of mission, engaging and flying in way point navigation mode while carrying 2 tow targets". *Lakshya-II* has been designed and developed by the Bangalore-based Aeronautical Development Establishment, specialising in UAVs and flight control systems.

Unmanned aerial platforms have seen greatly increased use in India over the past decade. While indigenous capabilities are under development, the armed forces and domestic security agencies already operate a variety of drones (mostly Israeli) in a slew of non-combat roles.

The widest use of UAVs is in eastern parts of the country, where they monitor Maoist activity in sustained counter-insurgency operations. IAI's lightweight, short-range Searcher UAV, along with its long-range, higher payload version, the Heron, are mainstays of the anti-Maoist operations.

All the three wings of India's armed forces have introduced UAVs and although their numbers are still limited these will only grow. The Indian Army was first to introduce these new weapons in the late 1990s, inducting the Israeli Herons and Searcher Mk.II from Israel Aircraft Industries. These new weapon systems have been effectively used by


Launch of the Lakshya PTA

the armed forces and have helped to early warn the Army and paramilitary on suspicious activities, conversations and intrusions along the Line of Control (LoC) in J & K.

While there are no clear details on the payloads of these UAVs, it is reported that the Searcher II is equipped with the standard day/night surveillance turret, while the Herons are similar to Israel's maritime patrol configuration, with an Elta Systems radar and a stabilised Tamam surveillance and targeting turret.

Anti-Naxal operations

After almost two years of efforts, the CRPF has successfully introduced and used UAVs to pick up ground conversation and movement of Maoist cadres in Chhattisgarh. A special squad of the anti-Naxal force undertook an operation in the jungles in which the UAVs not only picked up real-time imagery of Naxal cadres but also relayed live conversations amongst them.

"The conversation picked up by radars of the UAV was immediately routed to a squad of CoBRA commandos. The UAV experiment has finally worked with all the devices of the machine functioning optimally to give the forces an edge in anti-Naxal operations," a senior CRPF officer stated.

ADE's Nishant UAV

Buoyed by this success, security forces engaged in anti-Naxal operations in various states, including Chhattisgarh, have decided to employ different variants of Unmanned Aerial Vehicles ranging from

Controp

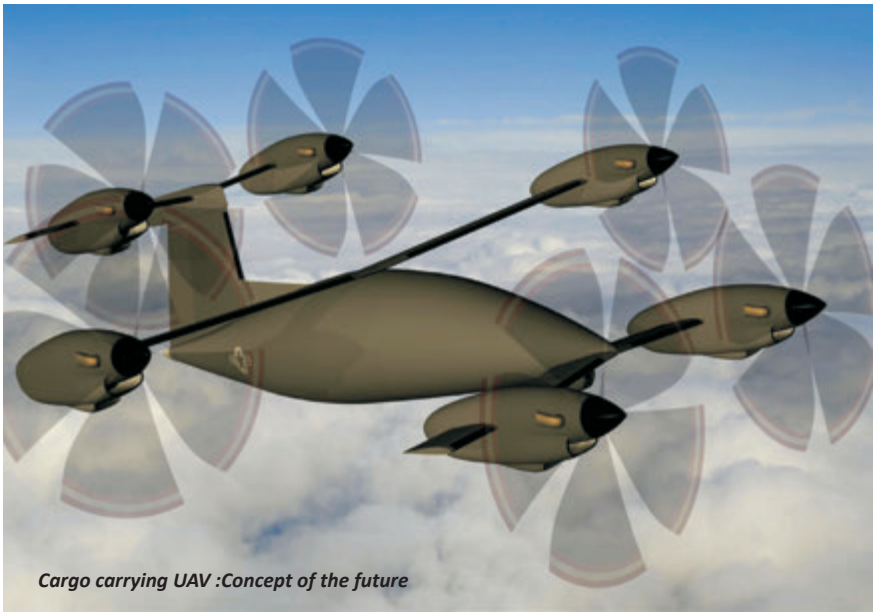
small drones to long-range surveillance ones as they are very useful in cases where immediate information is needed like during the abduction of Sukma district's collector in Chhattisgarh.

Guarding India's maritime coast

Aiming to strengthen coastal surveillance particularly in Gujarat, the Indian Navy commissioned an UAV squadron at Porbandar in January 2012, "the squadron comprising four units of two Israeli-made Searcher and Heron UAVs which will help in strengthening our coastal surveillance in the Arabian Sea along the coast of Gujarat."

This is the second squadron of UAVs deployed by the Navy along the long coastline of the country, the first being commissioned by the Navy at its base in Kochi a few years ago.

While UAV manufacturers are rapidly developing newer UAV versions for the military, in the long term it is foreseen that the civilian market is where the future lies. This has remained stagnant as UAVs are expensive and restricted from flying over populated areas. However, once these matters are resolved, the civilian market will likely experience a boom in small and mini-sized UAVs.



Cargo carrying UAV :Concept of the future

Cargo-carrying UAVs will predictably have tremendous impact on the airline industry, which is currently floundering under an increased burden of manpower costs. By autonomously flying cargo over great distances, such UAVs could well shape the future.

Ravi Rikhye

BAE Systems Mantis long endurance UAV is on offer to India

Changing Dynamics

The Indian Defence Market

US Deputy Secretary of Defence Ash Carter with Indian Defence Minister AK Antony at South Block, New Delhi

Russian Deputy Prime Minister Mr Dmitry Rogozin with Indian Minister for Commerce & Industry, Anand Sharma at New Delhi

Virtual back-to-back visits of US Deputy Secretary of Defence Ash Carter and Russian Deputy Prime Minister Dmitry Rogozin, in charge of that country's military-industrial complex, to India in mid-July 2012 demonstrated the heightened competition for India's defence import market, currently the largest in the world (India accounted for 10% of all global arms imports in 2011).

While in India, Carter stated that the US administration was committed to India's military modernisation and wanted to be the country's "highest-quality and most trusted long-term supplier of technology – not a simple seller of goods — in such fields as maritime domain awareness, counterterrorism, and many others."

In fact, India was the second-largest Foreign Military Sales customer of the United States in 2011, with $4.5 billion in total FMS transactions. Yet continued barriers on the United States side will limit the ability of the United States to be a key Western country supplanting the Russians' historical dominance.

One long-standing impediment to increased India-US defence cooperation, which is Russia's quasi-monopoly on Indian defense purchases, may soon be weakening. According to Russian calculations, during the past four decades the total value of all Russian-Indian military-technical cooperation exceeded $35 billion and indeed, Russia's arms sales to India remain the most important element of their overall relationship.

Bilateral defence ties have recovered from the problem-filled 1990s, when the Indian military had difficulties receiving adequate maintenance, support, and spare parts for its previous Soviet-era weapons purchases. At the time, the Russian defence industry was coping with aftermath of the collapse of the integrated and lavishly funded Soviet military industrial complex. Cash-strapped Russian firms now demanded hard currency for arms transactions instead of the traditionally favorable soft terms offered to New Delhi during the Soviet period.

Despite the problems that traumatised the Russian defence industry following the disintegration of the Soviet Union, Russia has remained the main source of most of these advanced weapons systems. For example, more than half the major surface combatants and submarines in service with the Indian Navy were constructed in Russia or the Soviet Union.

The Indian Army has also purchased almost 2,000 T-72 and T-90 MBTs plus thousands of BMP-1 and BMP-2 AFVs from the Soviet Union/Russia. Even many of the Indian-shipyard constructed ships are equipped with Russian-made weapons systems such as ship-to-ship and surface-to-air missiles, torpedoes, guns, and anti-submarine weapons.

Furthermore, Russian companies receive revenue from servicing and

upgrading India's primarily Soviet-based military hardware.

Even after end of the Cold War, Russian-Indian defence cooperation remains strong because of geopolitical imperatives, shared security concerns, and mutual economic benefits. Both countries fear radical Islamic terrorism, share concerns about regional instability in Central Asia, and are uneasy with US military hegemony and the rise of China.

Powerful interest groups in both countries also have a common interest in sustaining Russian arms sales to India. Russia's defence industry needs foreign sales to achieve economies of scale in some production runs as well as to sustain a manufacturing base that remains excessive for simply meeting Russian domestic demand. India has an enormous legacy of Soviet-based weapons that it needs to modernise, upgrade, and replace. In addition, Russian arms supplies continue to offer a good price-performance tradeoff.

However, recurring problems with some purchases along with India's changing geopolitical orientation closer to the West, especially the United States, could eventually lead to Russia's currently preeminent status in India's foreign military purchases falling to that of being the 'first among equals'.

During the 1990s, Indians complained about shoddy maintenance and insufficient spare parts for their Russian-built warplanes. In September 2007, the Indian government suspended payments under a $150 million contract to upgrade five Il-38SD anti-submarine patrol aircraft owing to their unsatisfactory performance in test flights.

The most notorious bilateral defence snafu has involved the Russia-Indian deal to renovate the Soviet-era aircraft carrier *Admiral Gorshkov* and transfer it to the Indian Navy. As things turned out, the Sevmash shipyard could not meet the terms of the original contract, which stipulated delivery in August 2008. After months of hard bargaining, Russia and India renegotiated the terms of the contract. India has ended up paying far more for the ship while waiting many additional years to receive the vessel, which is now supposed to be delivered in 2013, or five years late.

India's military establishment has also expressed concerns about the quality and timely delivery of other Russian naval purchases. For example, there are the lengthy time Russian shipbuilders have required to deliver multi-role stealth frigates and to upgrade the Indian Navy's *Kilo-class* diesel submarines.

The *Nerpa* nuclear-powered attack submarine that India has leasted from Russia has proved equally problematic. Under the lease contract, India provided hundreds of millions of dollars to finish construction of the *Nerpa* at Amur Shipyard in return for ten years' use of the ship and Russia's training of the Indian crew. The *Nerpa* was initially scheduled to join the Indian Navy as the INS *Chakra* in 2008, but production delays along with the accidental release of toxic gas from the ship's automatic fire suppression system in November 2008 delayed the transfer for four years until 2012.

India's has also experienced problems with the T-90 main battle tanks purchased from Russia in 2001. As of December 2011, the Heavy Vehicles Factory had manufactured only about 150 of the planned 1,000 T-90 tanks with the Russians accused of impeding the transfer of technology and of Russian-built assemblies needed to build the tanks.

At meetings of the India-Russia Inter-governmental Commission on Military Technical, the Indians complained of delays in receiving export clearances for vital equipment needed to repair Russian weapons systems already purchased.

On the other hand, Russian defence manufacturers were deeply disappointed by the failure of the MiG-35 to make it to the next round of the multi-billion dollar MMRCA competition for 126 aircraft. This tender, dubbed the combat aviation "deal of the century," was one of the most lucrative procurement aviation contracts in history, worth an estimated $15 billion. The Dassault Rafale was selected.

Almost half of the Indian Air Force combat aircraft inventory is obsolescent and needs to be replaced with new acquisitions. Geopolitical ties also remain strong, with the two countries elevating their relationship to that of a "Special and Privileged Strategic Partnership." In an attempt to sustain its market share, Russia has sought to meet Indian demands that Russia transfer more defence technologies

Russian-supplied Krivak III-class stealth frigate, INS 'Trishul'

and, in line with Moscow's increased willingness to import weapons and co-produce them, engage with India in more joint research, development, and production of new military systems.

Rogozin stressed that, "We want to move from basic trade to joint development projects with India in defence" and expressed interest in joint ventures involving the manufacture of cargo and passenger aircraft. The two countries are majorly engaged in the joint development of a multi-purpose fifth-generation stealth fighter, having completed the first stage of preliminary design contract.

Even though the Indian Government has chosen the US AH-64D Apache Longbow attack helicopters rather than the competing Russian Mi-28N Night Hunter attack helicopter and again, the Boeing CH-47F Chinook instead of the Mi-26, still, Russia will remain India's largest defence partner for the next decades given that the two countries have already signed arms deals worth some $ 11 billion in future transactions and have established several important joint ventures.

Russian defence firms have been counting on continuing orders from India to help cushion the decreasing opportunities in China. A few years ago, Russia's previously lucrative arms sales relationship with China decreased drastically, and Russian policy makers want to avert a similar fall in the case of India, whose purchases now account for about half the value of all Russia's foreign military sales.

Nevertheless, the growing competition from Western companies, problems with past Russian sales, potential budgetary cutbacks, and the increasing sophistication of India's indigenous defense industry could lead New Delhi to procure fewer Russian weapons in coming years.

Russia's difficulties offer opportunities for Western defence companies, but it was acknowledged "the US system can be confusing, rigid, and controls too many items for the wrong reasons." Carter recalled that, when he was Under Secretary of Defence for acquisition, technology and logistics, "There was a chart on my wall, outlining the 250 steps it takes to move a programme from development to delivery. It read like hieroglyphics." !

The United States took a long time to remove India's Defence Research and Development Organisation and the Indian Space Research Organisation off the Commerce Department's entity list, which identifies organisations that the United States fears could misuse U.S. dual-use technologies for proliferation purposes. He insisted that the administration was seeking to improve matters, both through long-term export reforms and by making "more anticipatory [decisions], looking at what partners are likely to want in the future, and beginning our thinking and processes earlier," with the aim of "building exportability into our systems from the start, so it doesn't consume time and money to do it later."

Exemplifying the new military relationship between India and the US is the Boeing P-8 long range maritime patrol and ASW aircraft, arguably the most advanced in the world.

For example, the Pentagon has a new fund to procure long-lead, high-demand items in anticipation of partner country requests. It also is seeking to develop a cadre of acquisition experts to help other countries define their requests and to streamline DOD's response.

Like Russia, Carter said that the United States wants to move beyond simply selling India items toward cooperative research, development and co-production. For example, in Hyderabad, Tata Advanced Systems Limited and Lockheed Martin have begun producing parts for the C-130J Super Hercules. India could help lower the costs of producing US equipment due to its more competitive labour costs.

India could assist this process if it raises its foreign direct investment [FDI] ceiling to international standards. India currently limits foreign investment in its defense sector to 26 percent. Another problem is that some of India's offset requirements are too onerous or excessively narrow.

Indian negotiators typically require foreign weapons suppliers to stipulate in new contracts a significant transfer of defence technologies to Indian firms. They also insist that other foreign firms rely less on selling complete turn-key systems and instead consent to engage in joint research, development, and manufacture of new defence technologies and systems. They regularly demand that foreign governments agree to allow Indian firms a role in producing (under licence), maintaining, and repairing the weapons.

Ash Carter correctly noted "both sides need to change, reform, and push ourselves to get to a place where US-India defence relations are only limited by our thinking, not by our capacity to cooperate."

Richard Weitz

"Combat Ready, Technology-Enabled, Networked Force"

Admiral DK Joshi CNS on future of the Navy

Text of the CNS speech on Navy Day 2012 : "The world has acknowledged India's economic trajectory and as the country continues to progress on the path of sustained growth, there is a growing acceptance that the maritime domain is the prime facilitator of our economic growth. More than 90% of our trade by volume and 77% by value is transported over the seas. Over 97% of our energy needs of oil are either imported or produced from offshore fields. Consequently, our economic growth is inextricably linked to the seas.

The *raison d'etre* of our existence is thus, succinctly encapsulated in the theme for Navy Week 2012: *'Indian Navy – Maritime Power for National Prosperity'*. Our mandate is unambiguous: – to be 'Net Security Providers' wherever the country's sovereign interests may lie in the maritime domain. Therefore, whilst the Navy is prepared to meet any form of traditional threat, it is constantly acquiring capabilities and realigning its operational ethos to meet emerging security challenges. Accordingly, the Navy has maintained its momentum towards enhancing maritime security and safeguarding our economic and strategic interests. Today, we stand committed to providing stability, not just to the Indian Ocean Region, but also for safeguarding our interests across the oceans.

It is, therefore, with good reason that the tempo of Naval operations in 2012 was relatively higher. In the last six months alone, our ships have been deployed from the Mediterranean Sea to the Western Pacific, demonstrating our reach and endurance at extended ranges. We also continue to develop inter-operability with friendly foreign navies through bilateral exercises. Maintaining our focus on the diplomatic role, INS *Sudarshini*, the Navy's sail training ship, is currently on a six month MEA sponsored voyage to ASEAN countries, in commemoration of 20 years of India-ASEAN diplomatic relations.

As regards anti-piracy, robust action by the Navy close to the Indian coast has been a strong deterrent to piracy. Sinking of four pirate mother ships last year, clearly signaled India's resolve to curb this menace. Since then, no successful pirate attacks have been reported within 450 nm of our coast. Similarly, in the Gulf of Aden, no ship escorted by the Indian Navy has been pirated during the last four years. Over 41 piracy attempts have been foiled by us and more than 120 pirates arrested. Statistics show that successful attempts, which peaked in 2010, have declined since last year. Our efforts will gain a stronger legal basis, with implementation of the Anti-Piracy Bill, currently under Parliament's consideration. The final solution, of course, lies ashore in Somalia and till the time those issues are adequately resolved, we expect the situation to remain.

SIKORSKY

Coastal security continues to remain an important aspect of the Navy's comprehensive approach towards maritime security. A phased implementation of initiatives like the National AIS network, coastal radar chains and Joint Operations Centres in progress now, will contribute towards enhancing our situational awareness in the maritime domain. The *Sagar Prahari* Bal has been created and 15 interceptor craft have been inducted so far. ICG and coastal states have also commenced augmenting their hardware and infrastructure. As we upgrade infrastructure and induct hardware, our coastal security readiness will continue to further improve.

We have also taken initiatives to shape our future Navy in the realm of Policy and Plans, with publication of three documents. These are the *Maritime Capabilities Perspective Plan 2012-27*, the XII Plan document and the XII *Infrastructure Plan* document. A fourth document, the *Maritime Infrastructure Perspective Plan,* is under compilation. The Indian Navy is evolving continuously to meet emerging challenges to our maritime interests, and our focus has been to evolve a force structure commensurate with our mandate in the maritime domain. Threats, missions and affordability have, therefore, remained dominant factors in force structure planning. Modernisation and enhancement of the Navy's capabilities is an ongoing process, to meet emerging maritime challenges/ threats. These include aircraft carriers, stealth frigates, destroyers, corvettes, amphibious ships and submarines. IN would also be inducting state-of-the-art aircraft and helicopters to augment our surveillance and integral aviation capabilities. Our preferred choice of inducting ships and submarines has been through the indigenous route and of the 44 ships and submarines presently on order, 42 are from Indian shipyards, including private shipyards.

Over the next five years we expect to induct ships/submarines at an average rate of five to six ships per year. Amongst the major projects, under construction in Indian shipyards, are ships of *Kolkata* Class (P-15A), P- 15B ships which are an advanced version of the *Kolkata* Class and the P-75 submarines, all at Mazagaon Dock Limited, Mumbai. Anti Surface Warfare Corvettes are being series built at Garden Reach Ship-builders, Kolkata. In addition, Naval Offshore Patrol vessels are under construction both at public and private sector shipyards. The construction of the Indigenous Aircraft Carrier though delayed is now picking up pace at Kochi Shipyard. In 2013, we expect to induct one *Kolkata* class destroyer, one P-28 ASW Corvette, one Catamaran Hull Survey Vessel, one Offshore Patrol Vessel and sixteen Fast Interceptor Craft.

Amongst the overseas projects, there has been a delay in the delivery of INS *Vikramaditya*, which has sailed for more than 100 days in the recent past and completed a majority of her equipment and aviation trials. The revised schedule envisages the delivery of the ship in the last quarter of 2013.

The scheduled induction of P-8I Long Range Maritime Reconnaissance aircraft commencing 2013 would augment the aerial surveillance capability, thereby enhancing the Maritime Domain Awareness in IOR and IN area of interest.

Recent years have also witnessed a sustained focus on enhancing our operational, technical and administrative infrastructure. Phase I of the Naval Base at Karwar, under *Project Seabird*, has been completed this year. We are now progressing towards the second phase, which would substantially enhance the operational and technical infrastructure in the naval base. In addition, we are also setting up additional Operational Turn Around (OTR) bases, Forward Operating Bases and Naval Air Enclaves all along the coast which would enhance the reach and sustainability of our surveillance effort.

INS Rajput

AGUSTAWESTLAND

Sea Harriers on board INS 'Viraat'

INS Trishul

This year the Navy has provided a renewed impetus and focus towards creation of operational and administrative infrastructure in the Andaman and Nicobar Islands and the Lakshadweep and Minicoy Islands. These islands are the country's strategic outposts and augmentation of the facilities would enhance our reach and enable extended presence in the region.

The biggest strength of our Navy is our well trained Human Resource that derives its strength and motivation from the finest traditions inherited from our predecessors. 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 redeem this shortfall. Shortage of service personnel is also being progressively reduced through an additional recruitment programme.

With regards to sports, it is a matter of great pride that our sportsmen have consistently done the country proud in the International arena. 49 Naval sportsmen have so far represented the country at various International sports events during the current year and have won 3 Gold, 2 Silver and 5 Bronze medals, in shooting, boxing, wrestling and canoeing. Sanjeev Rajput of the Navy shooting team won a gold medal during ISSF World Cup and also participated in London Olympics 2012. Omkar Singh of the Navy shooting team has been bestowed with the prestigious *Arjuna Award* for sporting excellence for the year 2012.

The most notable event in 2012 has been the flagging off of the Indian Naval Yacht *Mhadei* on 01 Nov 12 from Mumbai. Lt Cdr Abhilash Tomy, the skipper and the sole crew member, has embarked on a unique voyage termed *Sagar-Parikrama* II, aiming to circumnavigate the globe.

Let me conclude by stating that we are committed to create and sustain a combat-ready, technology-enabled and networked force, capable of safeguarding our maritime interests and projecting combat power across the littorals. We seek to evolve relevant conceptual frameworks and acquire the war fighting capabilities to operate across the full spectrum of conflict on sustained basis. Ensuring combat readiness will therefore remain our primary focus. We will also be prepared to undertake benign and humanitarian tasks in our region, whenever required. Our operational endeavors shall be underpinned by continuous up-gradation of our human skills and a willingness to transform as required by adopting change".

Looking Ahead

F-16Bs of No.9 Squadron (Griffins) PAF enroute to the Red Flag Exercise in 2010

An Interview with

Air Chief Marshal Tahir Rafique Butt

Chief of the Air Staff, Pakistan Air Force

Q: Over the past years, PAF has adopted a new counter Terrorist Doctrine, with relevance to Army support operations in North Western Pakistan. Kindly elaborate upon the Pakistan Air Force's doctrine as it is officially enumerated today.

CAS : In the operations that started a few years ago under the instructions of the Government of Pakistan, we started with humble contributions by providing support to Pakistan Army through a variety of direct and combat support missions. Hence, we undertake a range of missions in support of the national cause that include troop airlift, ISR, medical evacuation, etc. In all these types of missions, we have learnt on-the-job through ground work and high degree of coordination between various tiers of Pak Army and PAF. Along with these, with the induction of advanced support aircraft, attack platforms and ISR, we have overcome many challenges. Today, by a great degree, we are also successful in *Time Sensitive Targeting*. We modify our engagement strategy with changing ground environment and sensitivity of the situation. Being aware that these operations are carried out against miscreants and terrorists on homeland soil, as a principle, we engage only specific targets. We have devised and enforced comprehensive procedures to legitimise targets before engaging them and use PGMs under very stringent ROEs to obviate/minimise collateral damage.

Q: What are the greatest odds presently faced by the PAF:

- ***Limited sources of equipment origin?***
- ***Funding stringency?***
- ***Political compulsions?***

CAS : PAF has recently acquired state-of-the-art military hardware from various countries. In that, the Government of Pakistan has been very supportive of the PAF's requirements for obvious reasons. While PAF currently faces no shortage of hardware, we believe that as the world is undergoing economic challenges, we have our own set of such challenges. Therefore, although we all face limited funding, I would not take it as an isolated problem with the PAF. Moreover, realising the importance of Air Power, the Government of Pakistan has always provided PAF with what has been

considered necessary. Recent arrival of high-tech equipment including aircraft, radars and weapons are a testimony to these claims.

Air Chief Marshal Tahir Rafique Butt, Chief of Air Staff, Pakistan Air Force

Q : Please review the possibility of ordering a second batch of F-16s C/Ds to augment the present single squadron with this type. It has been our belief that PAF will eventually get the numbers originally projected.

CAS : PAF along with its F-16 C/Ds also got the previous batch of Blk.15 F-16s upgraded to the same standard as Blk.52s. These would therefore supplement the F-16 C/Ds. With the induction of these aircraft, PAF now has a sizeable fleet of F-16s. The option of additional F-16s also remains open. At present, we are concentrating on the operationalisation of all these aircraft.

Q : Of late, there has been an intensification of contacts between Pakistan and Russia which could include an expansion in military relationship. You, Sir, also visited Moscow for the Russian Air Force centenary celebration. Any comments?

CAS : The Government of Pakistan has always pursued a foreign policy that respects international conventions, promotes peaceful coexistence and believes in enhanced mutual cooperation with all the global players. Of late, due to changes in the global and regional economic climate, the Government considers it a good opportunity to improve and enhance the existing relations with Russia. In continuation with the same, PAF would certainly like to move ahead in this direction as we believe that we have a lot to share for the mutual benefits.

Q : The PAF has always stressed on highest quality and standards of training in all aspects. The PAF Academy at Risalpur is now not only imparting flying training at various levels but has affiliated with Peshawar University to enhance technical skills. Kindly give a brief on the qualitative effect this is having on the overall efficacy of the Service.

CAS : You are absolutely right that PAF has never compromised on the training standards; hence, we put in all our efforts. Firstly we select the quality human resource and secondly, groom it to develop into best professionals. As you know previously only engineering cadets were going through a four years degree programmes. PAF Academy has recently upgraded its academic curricula for other streams as well as now all under training cadets are being put through a four years degree programme with Air University. We are sure that this change would take the quality of our academy graduates a notch higher and they would be able to deliver even better whichever branch of the PAF they join. On affiliation issue, let me update you that our technical and engineering programmes are run under the auspices/affiliation of NUST, Karachi University and the Air University.

Air Force and Army cadets at the PAF Academy Risalpur

Q : Please review the specific areas of focus in transforming the PAF into becoming an increasingly technologically proficient and in formation-networked air arm.

CAS : PAF understands that with the induction of technologically advanced weapons and infrastructure, human resource needs to be developed at par. Therefore it has started a major revamp of in our day to day operations besides introducing redundancies during wartime. Participation in international exercises has been an opportunity to learn and PAF now stands abreast with any modern Air Force of the world. The latest C4I Branch of the PAF in coordination with Engineering, Air Defence and Operational Branches continue to carry a high degree of integration and modernisation in the PAF.

CAS : PAF as an organisation adopts safety as a norm and culture rather than just a slogan. I would like to apprise you that 2010 was an accident free year, making history in PAF. This was a feat which very few Air Forces have achieved in history. At the same time we consistently address the flight safety lapses that lead to flying accidents while we address all these problems with a positive spirit, year 2010 gave us the hope that we are capable of achieving enviable results and *Inshallah* we will do it again.

PAF F-7 in air exercises with Mirage 2000 and F-16s over the Gulf

Women are increasingly being integrated into various branches of the PAF

technical training where manpower is being skilled on sophisticated systems through a very scientific approach. Besides training on modern lines, PAF has also initiated infrastructure modernisation including the information technology sector and we have achieved phenomenal improvement

Q : Flight Safety must remain paramount: there have been concerns that the PAF has suffered higher than normal attrition over the past few years. What measures have been taken to reduce such flying accidents?

Q : PAF has participated in several international air exercises with other air arms. Considering the large numbers of Chinese-origin aircraft in PAF inventory, are there any plans to have joint exercises with the PLAAF.

CAS : PAF has been a participant in various international exercises for a considerable time now. Besides *Red* and *Green Flag* in the US, the list of exercises with regional countries is exhaustive. Under the greater ambit of cooperation with regional Air Forces, PAF has also recently started conducted Exercise *Shaheen-I* with the PLA Air Force. In future PAF has plans to maintain this drive and conduct more exercises.

Q : The JF-17 Thunder is an excellent example of how a need-driven programme of this kind can succeed in spite of multiple technological and logistical difficulties. Please review the role of this combat aircraft in PAF service over the next two decades?

Mainstay of the PAF in the next decade will be the Sino-Pakistan JF-17Thunder

MFI-17 Super Mushshak at Risalpur

CAS : The JF-17 undoubtedly is a state of the art programme that ensued as a result of the hard work of our engineers, technicians and test pilots. All this would also not have been possible without the cooperation of our long devoted friend, China. JF-17 is a medium to high-tech aircraft with an attractive price tag. With the capability of carrying variety of weapons it is a true multi role aircraft with variety of weapons/in all three roles i.e. NA, NG and NC. It is thus a true multi-role aircraft. PAF plans to induct up to 300 aircraft in its inventory and hence it would become our mainstay.

Exhaust of the RD-93 engine as fitted in the JF-17

Q : Is the RD-93 engine proving reliable? Any plans to re-engine the JF-17?

CAS : The RD-93 engine is a reliable engine with excellent performance. At the moment there are no plans to re engine the JF-17.

Q : The Mushshak basic trainer has been in service for several decades. What types of more modern and appropriate basic training aircraft could replace the Mushshak and by when?

CAS : The MFI-17 Mushshak is now truly the trainer of generations in PAF. It delivers excellent performance in training, aerobatics and light communication roles. The student pilots after flying this aircraft feel comfortable to shift on jet trainers such as T-37 or K-8. This is why even today many other Air Forces of the world are operating Mushshak produced by AMF Kamra. It suits our requirements very well therefore we have upgraded these to the Super Mushshak some time back. We are satisfied with its performance and have no plans so far to replace this trainer.

The K-8 Karakoram jet trainer has replaced the earlier T-37 and FT-5 with the PAF

However, it may be remembered that MF-17 of today is vastly different from the one we were operating ten years ago.

Q : Does the Chengdu J-10 (FC-20) multi-role fighter meet the near future requirements of the PAF, particularly to address the increasing qualitative imbalance with the IAF?

CAS : The aircraft is a very good choice for PAF and at the moment we are in the process of evaluating various aspects related to its possible future acquisition.

The Falco UAV

Q : Any interest at this early stage in the Chinese J-20/J-31 next generation stealth fighters which could be considered as contemporary with the Russian PAK FA (T-50) fifth generation fighter?

CAS : PAF has no plan to be sucked into any regional arms race. The current process of inductions is only to undergo required modernisation and maintain minimum credible deterrence. We are a dynamic and progressive Air Force. Therefore we always have an eye on the future. Any option to keep our traditional force balance is not in our interest but also in the interest of the region.

Q : There are increasing numbers of UAVs being deployed for surveillance and target acquisition missions: does the PAF have any plans to acquire UAVs for combat?

CAS : Killer drones are an excellent capability. PAF, besides the research in this field, would certainly like to benefit from this technology especially with respect to our continuing war on terror.

Q : Although the IAF has always been considered as main adversary of the PAF, there are many commonalities between the two air arms in terms of history and geography : can one work out any confidence building measures to promote human relationships including golf tournaments between retired officers of the two air forces - and perhaps even dream of taking part in Air Show events with formation aerobatic teams?

CAS : We do not believe in closing any options. However, it could work better after the CBMs, which the two countries are undertaking. We would have to wait and see how we progress on some of the standing issues before we start mutual cooperation with the IAF. In fact in January 2011, the Ski Federation of Pakistan which is patronised by the PAF, sent a ski team to participate in the first South Asian Winter Games held at Auli, Uttarkhand, India.

The PAF Air Chief with model of JF-17 Thunder

Participant at the South Asian Winter Games in Auli, Uttarakhand

Large scale model of the JF-17 Thunder at the PAF pavilion

What an IDEA, Sir ji

The International Defence Exhibition and Seminar at Karachi, 2012

Understandably held under a tight security cordon, the Karachi-centred International Defence Exhibition and Seminar (IDEAS) 2012 was visited by a number of defence delegations and industry during the period from 7 November 2012. According to Commodore Siddiq Akbar, spokesperson for the *Defence Export Promotion Organisation*, "we are satisfied with the response, despite the fact that this is taking place after a gap of four years," and that "this event gives our own companies the opportunity to exhibit their products – something that is not easy when we go to similar exhibitions elsewhere."

Tensions were understandably high, as the Rangers headquarters in downtown Karachi had been attacked that very morning with numerous casualties suffered. Within the IDEAS campus the regular Army maintained strict vigilance with combat-ready troops deployed throughout. All roads leading to and around the Expo Centre were closed for traffic during the event, and the blockage created bottlenecks in many other parts of the city.

The Sino-Pakistan JF-17 Thunder fighter was given pride of place, with an actual aircraft on static display alongside the K-8 Karakoram jet trainer. Also on outside display was the Al-Khalid Main Battle Tank, now being offered for export, but without success thus far. As Director Coordination Brigadier Mazhar Mumtaz said, "it is not easy to sell tanks and aircraft. The bigger the equipment is, the bigger the competition. But we are sure to get a breakthrough soon. Countries in Africa, the Middle East and Central Asia are a potential market for Pakistani defence equipment. We are already exporting arms to many of the countries in these regions. It is important to realise that state-level communication and diplomatic linkages matter a lot in this trade."

National flags exemplifying the close defence relationship between China and Pakistan

Lady Naval Officer at the Pakistan Navy stand

The Gripo radar has been integrated in several PAF fighters

However, it was tacitly admitted that Pakistan was being continuously sidelined because of its geo-political situation. "Saudi Arabia was about to buy Al-Khalid tanks from us. Everything was done; even the contract was ready, but

SIMON WATSON

The Diehl Group were present at IDEAS 2012

This JF-17 on display at IDEAS was from No.26 Squadron ('Spiders')

Models of the JF-17 and Falco UAV

Model of the Aspide multirole missile from MBDA

The Eurocopter Fennec light utility helicopter is successor to the earlier Aerospatiale Lama in the high mountains of the north.

the deal was called off at the last moment," rued a senior official: "our technology is not as good as the Europeans and the US, but how many countries can make tanks, aircraft and air defence systems? The market is huge. It's just that penetration into the buyers' market needs strong political will."

Global Industrial and Defence Solutions (GIDS), an umbrella organisation that owns seven companies in Pakistan and manufactures a range of system from UAVs, command and control radar systems, to Air Combat Manoeuvring Instrumentation Systems. The GIDS pavilion had dummy missiles and high-tech surveillance cameras on display. CEO Zubair Iqbal Malik stated that the organisation employs around

Range of weapons carried by the JF-17 on display alongside the aircraft at IDEAS 2012.

60,000 engineers, scientists and workers. "Our aim is to become a completely self-sustained organisation in the next few years," he said, referring to the entity's dependence on guaranteed business it receives from Pakistan's armed forces. "GIDS was recently established in 2007, but we have been able to make our presence felt."

The main halls were dominated by displays of the Pakistan's Ordnance Factory, the Karachi Shipyard, and Kamra-based Pakistan Aeronautical Complex while amongst the foreign participants, China and Turkey had their own pavilions. Conspicuous by their absence were US companies while only a few European firms were present, including those for Italy and France.

The K-8 Karakoram advanced jet trainer with pilot of the 'Sherdils' aerobatic team

The Al-Zarrar main battle tank has been developed and manufactured by Heavy Industries Taxila (HIT) for the Pakistan Army.

The Al-Khalid (arabic for 'Immortal') also known as MBT-2000, was co-developed during the 1990s by China and Pakistan.

China's growing assertiveness

DF-31 ICBMs of the Second Artillery Corps on their road-mobile transporter-erector-launchers at a military parade in Beijing.

Shaping the Indian response

Nearly 200 years back, Napoleon had prophetically stated that "let China sleep, for when she wakes, she will shake the world." Indeed, China has gone far beyond this truism for the world to acknowledge that, since the past decade, China is the world's fastest growing economy, with the largest, if not the most powerful, Armed Forces in the world plus foreign reserves at $ 3.2 trillion, far exceeding even the sole superpower, the now economically weary and strategically fatigued US, all translating into China's ever growing global clout.

China's burgeoning financial and consequently its military might continues to be on a rapid upswing propelled by its ancient civilisational wisdom of realpolitik embellished by a strategic vision and nationalistic ambitions which are unparalleled. That China will be a super-power by 2025, if not earlier, will be understating a stark reality. If the 21st century has to be an Asian century, as repeatedly proclaimed by many geo-political luminaries, China leads the way well ahead of the other players on the scene including India, Japan, S.Korea, Viet Nam, Malaysia and any others. China is usually bracketed with India as the lead players in emerging Asia but India merely plods along, never having risen yet to its true potential because of its inner contradictions. That China sees India as its main rival globally, regionally, economically and militarily, makes the growing asymmetric chasm between the two neighbours and Asian giants a serious cause for worry, in the foreseeable future, for India.

China's Stated Aims

As China builds up a formidable military machine, it is conscious of inculcating a responsible image for world consumption in keeping with its growing global status. Thus China has been, since 1998, issuing every two years White Papers on national defence with the latest in the series issued late in 2010 on China's National Defence.

This article comprehensively covers all macro-issues concerning national defence.

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

Most strategic analysts the world over, and particularly its neighbours, however, dismiss China's noble-sounding rhetoric as nothing more than a public-relations exercise as China's actions in the past few years, all across Asia, have been anything but contributing to regional harmony. On the contrary, China is well on the way to become a regional hegemon as many of its actions clearly show especially the turbulence it has created by its muscle-flexing in the many waterways which lap the Chinese coastline whether it is the South China Sea or the East China Sea including many unfair claims on various island territories in SE Asia.

One of the manifestations of changing Chinese doctrine is the introduction of a new cliché in the lexicon of Chinese think tanks, namely 'Grand Periphery Military Strategy'. This presupposes the fact that the People's Liberation Army, surprisingly to many outsiders, lacked the capability of defending its 'far flung borders.' Now other Chinese military thinkers are reinforcing this newer strategy to be adopted in the face of rapidly changing geopolitical dynamics in South Asia, Central Asia, Southeast Asia and Northeast Asia. The Chinese move to expand high speed rail networks and equipping over 1000 railway stations with military transport facilities points towards concrete military steps being taken in this regard. This will ensure rapid offensive deployment as required to the many and diverse border regions of China. Thus proactive military actions along several theatres will be a possibility. The excellent fast rail network to Tibet is a pre-eminent example of adherence to the 'Grand Peripheral Military Strategy' of China and further its connectivity to Nepal and the Chumbi Valley is being planned for the near future. In addition, the rail link being conceptualised along the Karakoram Highway linking Xingjian, through the disputed territory of Pakistan Occupied Kashmir, to the warm water port of Gwadar in Baluchistan along the Makran Coast is another example of Chinese strategic determination to extend its influence beyond its peripheries and dominate regions well away from its borders.

As one of the signatories of the United Nations Economic and Social Commission for Asia and the Pacific-sponsored 8100 km long Trans-Asian Railway, China has come out with a plan to build high-speed rails to Laos, Singapore, Cambodia, Viet Nam, Thailand and Mynanmar along its southeast periphery. It has also got the signal to construct the China-Iran rail that will pass through the Central Asian countries of Kyrgystan, Tajikistan and Afghanistan.

Michael Caine and Ashley Tellis of the *Carnegie Endowment for International Peace* in their seminal

Yuanwang 2, a tracking ship of the PLAN, pictured at Waitemata Harbour, Auckland, New Zealand, following a mission in support of the Shenzhou 6 spaceflight.

work *Interpreting China's Grand Strategy: Past, Present and Future*, have opined that "the continued increase in China's relative economic and military capabilities, combined with its growing maritime strategic orientation, if sustained over many years, will almost certainly produce both a re-definition of Beijing's strategic interests that directly or indirectly challenge many of the existing equities."

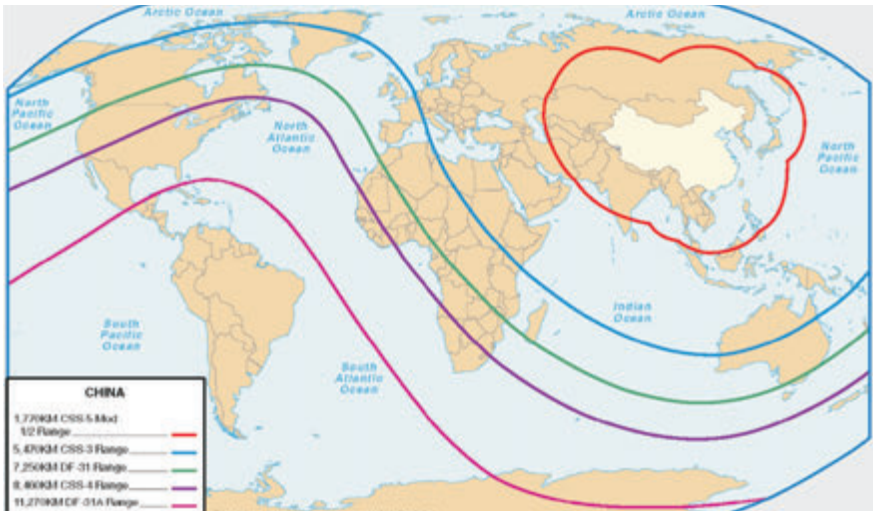
China's Defence Spending

Freeing China from restrictive Maoist economic thinking in the mid 70s, then China's leader Deng Xiaoping had unleashed market reforms which *The Economist* aptly summarised as "….. the most dynamic burst of wealth creation in human history." This growing economic clout is translating into military muscle and modernisation of its forces at a pace which no country in the world can match. As is widely known, China's declared defence budgets are normally half of their actual value. From an annual defence budget of $ 92 billion in 2011 the budget in 2012 shot up to $ 106 billion, which, in real terms, would thus be around $200 billion–just for a year! According to IHS Jane's, China's defence budget is set to double by 2015 to a $ 238 billion and exceed that of all major Asia-Pacific countries put together. Japan will remain in defence spending a distant second with around $ 64 billion. India with a falling rupee depreciation, heavy fiscal deficit and large government debts will be left far behind in defence allocations. The overall strategic implications for the entire Asia-Pacific region of China's triple digit defense spending can easily be comprehended.

In the overall budget for 2011, for the first time the budget for Internal Security outstripped the Defence budget of the Chinese and this points towards internal stability concerns of China.

China's Core Interests

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



A map detailing the approximate reach of China's strategic missile arsenal.
Note: territorial boundaries are not necessarily authoritative.

Tibet came in as a major "core interest" after its forcible annexation in 1951 and so did the island of Taiwan, which was ceded to Japan in 1895, and is today an economically vibrant self-governing democracy, calling itself the Republic of China. The People's Republic of China has repeatedly warned the world that it will invade Taiwan if it ever declares independence. More recently, the restive province of Xingjian(formerly East Turkestan) , the huge area to the west of China which has seen frequent clashes between the local Uighur Muslims and the Han Chinese being settled there from mainland China, has also been added to the list of China's "core interests".

China has vociferously warned of its "core interests" in the South China Sea as "non-negotiable" to nations like Viet Nam, Malaysia, Philippines, Brunei which lie astride this waterway. It has cautioned the US to keep its naval vessels away from this waterway and only last year, had aggressively cautioned an Indian naval vessel, INS *Airawat* which was sailing in the territorial waters off Viet Nam where India is oil prospecting.

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

China's Defence Modernisation

China has shifted gears since the collapse of its major threat, namely the Soviet Union, in the early nineties of the last century. Their paramount leader, Deng Xiaoping had ordained that "small and medium local conflicts and not general wars were the most likely threats." Gradually the Chinese have, especially after the Gulf War, honed their doctrine to " Local Wars under Conditions of Informationisation." China's military modernisation strategy is based on the " PLA's simultaneous transformation" through mechanisation and informationisation. The Chinese have been rapidly building up their Information Warfare capabilities. There are reportedly 30000 computer professionals and two hacker brigades in the Chinese forces.

✈ Strategic Forces : China maintains nuclear deterrence employing land-based

ICBMs. China has currently around 250 nuclear warheads in its inventory with the arsenal growing. It has around 60 ICBMs (DF-31 of 8000 kms and DF-31A of 13000 kms range). By 2020, experts opine that it will have 100 ICBMs and 6 *Jin*-class nuclear submarines each armed with 12 sea launched ballistic missiles. Besides DF-25 medium range ballistic missiles, China's Second Artillery Corps has over 1000 short range ballistic missiles with conventional warheads.

✈ Land Forces : The PLA is the world's largest army with 1.6 million men. As per the Military Balance, it has 40 Divisions to India's 28 with 7660 main battle tanks versus India's 3900 and nearly 18000 artillery pieces to India's little over 10000. Besides there are nearly 60 Divisions worth of the People's Armed Police as an internal security force, the bulk of which are demobilised PLA divisions.

✈ The PLA Navy : For expanding naval ambitions not only in the seas surrounding it, but for naval operations against Taiwan and in the entire Asia-Pacific to thwart even the US flotilla and the navies of the other countries in its vicinity, the Chinese Navy is the focus of modernisation. By 2020-25, it could have three aircraft carrier battle groups, 60 submarines including 10 nuclear and nearly 80 surface combatants. The Indian Navy may have just two/three carriers and 16-18 submarines with 2 nuclear submarines and 58 surface combatants.

✈ PLAAF : The Chinese Air Force is currently undergoing a feverish qualitative upgrade. Its vintage fleet is being rapidly replaced by third and fourth generation fighters like the Russian Su-27 and Su-30 and its Chinese copy, the J-11. The mainstay is the J-10 which is reportedly a F-16 equivalent fighter. It is also jointly developing the JF-17 multi-role aircraft with Pakistan which is programmed to receive 250 of these. Like India, it already has air-to-air refueling and an AWACS capability. By 2020, it will have over 2300 fourth/fifth generation combat aircraft compared to India's 750 aircraft in the best possible modernisation scenario. For India thus this asymmetry remains operationally unacceptable. Importantly, it is planning to build 60 airfields in Tibet alone.

✈ China tested its first anti-satellite missile in early 2007 and in 2010 conducted an anti-ballistic missile test. It has launched three manned missions and a lunar orbiter. It is planning nano satellites that will serve as space mines and by 2020 plans to have 200 remote sensing satellites and a military space station---- the first in the world !

✈ Rapid Reaction Forces: China is developing rapid reaction capability for catering to speedy and potent responses to varying battlefield contingencies. These high-technology based rapid reaction forces will cater for small scale intense local military operations or in support of pre-emptive operations. The Chinese already have a fully operational Airborne Corps and another Airborne Corps HQ is under raising. These forces could be tasked also in support of China's 'core interests' as specified above, in case of contingency.

A pair of PLAN Xian JH-7A 'Flying Leopard' attack aircraft in formation take off.

China's Water Hegemony

Tibet is the water reservoir of India. China virtually exercises control over the waters of rivers like the Tsangpo (Brahmaputra), Indus and Sutlej flowing into India owing to is superior upper riparian position in the Tibet plateau. Substantiated reports convey the alarming fact that China plans to unilaterally divert waters of the Brahmaputra to its vast arid areas in the north and west. It has also commenced work to dam some other rivers flowing into India. India's hydel project on the

Brahmaputra, upstream of Pasighat,has been in suspense for a very long time. Chinese callous attitude in its areas in water management upstream of the Indian rivers has resulted in two devastating flash floods for India. In June 2000 parts of Arunachal Pradesh were suddenly flooded due to the bursting of Yiong River Dam or release of water from that dam. In 2005 again, the Sutlej river was flooded in Himachal Pradesh from the Pare Chu Lake in Tibet causing havoc to many low lying villages in some regions of Himachal Pradesh in the vicinity of the Indo-China border. In addition, its proposed construction of the 116 metre high Zangmu Dam on the Tsangpo in eastern Tibet in a high seismic zone can cause havoc to Assam in the event of a major earthquake in the region.

Although Prime Minister Dr Manmohan Singh himself assuaged the concerns of Indian parliamentrians in the Rajya Sabha regarding China's diversion of waters from the Brahmaputra or damming it inside China, India will be well advised to ensure its satellite intelligence coverage of China's activities in this field are zealously monitored. China has a propensity to keep its water strategies under wraps and does not allow any outsiders for on-site visits. It has disregarded UN recommendations on water and information sharing on earlier occasions.

A Wake-Up Call !

Notwithstanding the frequent rounds of dialogue between India and China since the last few years to discuss many vexed issues between the two countries including the contentious border issue, Chinese actions towards India are hardly encouraging. China appears to be still suffering from the 'Middle Kingdom' syndrome and resents Indian aspirations as the second Asian power. Its 'string of pearls' stratagem aims at the strategic encirclement of India, so confining India to the backwaters of the Indian Ocean and restrict India to within South Asia.

China's nuclear weapons- cum- missiles nexus with its client state, Pakistan, and modernising the Pakistani Armed Forces is singularly aimed against India. For China, Pakistan is a low-cost guarantor of security against India and China is a high value guarantor of security for Pakistan against India. Since the last two years or so, the Chinese footprint in the disputed POK region is growing under the garb of engineer personnel being stationed in the region (approximately 7000 to 10000 personnel already there) and reports suggest that parts of POK may be leased to China for 50 years or so. China and Pakistan appear to have decided to convert POK as Pakistani territory and in doing so, legitimise the 5180 sq kms of POK ceded by Pakistan to China in 1963 as Chinese sovereign territory. With these ominous developments, India thus faces yet another front to secure against Pak-China collusion.

China has successfully made serious inroads into India's immediate neighbourhood through Nepal, Bangladesh, Mynamar and Sri Lanka, providing them subsidised arms and military training facilities besides constructing strategic infrastructure for them.

China's continued mischief in issuing stapled visas to Indian citizens from J&K visiting China and laying territorial claims

A Chengdu J-20 stealth aircraft takes off on test flight.

to Arunachal Pradesh, calling it 'Southern Tibet', all point towards China's evil machinations towards India. Despite India's continuing friendly overtures towards China, at times bordering on the submissive, it appears that China will, most likely, adopt a confrontationist policy towards India. Competition for foreign markets and global influence are likely to spur multiple challenges between the two rising Asian giants and thus India needs to factor in the myriad Chinese stratagems in the long term perspective.

An Indian Response ?

The not so 'peaceful rise' of China and its provocative actions vis-à-vis India some as already stated in this article portends more competition than cooperation between the two Asian giants. China's own stated reunification policies points to the fact that it can use military power to regain certain parts in its neighbourhood which it perceives to be its own. Thus, India even as it endeavours to resolve all contentious problems with China in a mature and peaceful manner, must gear up to face the Chinese dragon squarely for China only respects strength. In order to do that we need to firstly, correctly assess likely Chinese threats both in the short-term and long term perspectives. In particular, the Indian government must not play down Chinese challenges in any form. Secondly, we must address, with determination, the military asymmetry to counter the threat from China and ensure no bureaucratic sluggishness or procedural shortcomings in the identification of and procurement of our military hardware for all the three services in a speedy time-frame. The three services must be made capable for offensive operations in Chinese territory. Thirdly, we must pay adequate attention to further develop our strategic infrastructure leading to the Indo-China border. Nuclear and space assets require to be vastly improved as well as our electronic and cyber warfare wherewithal. Fourthly, under an international umbrella we need to go for either bilateral or regional water-management treaties between India and China and the other Asian lower riparian states. Fifthly, India needs to take the lead to energise all Asian groupings like the ASEAN to ensure peace and stability in the Asia-Pacific region with active cooperation of the US and Australia.

It is about time that India carried out a reality check of its overall capabilities vis-à-vis China. It now needs to upgrade its military strategy from dissuasion to deterrence. For effective deterrence, India needs to enhance the capabilities of its nuclear forces by fielding 5000 km range Agni IV and V Intermediate Range Ballistic Missiles and sea-launched long range missiles by nuclear subs to complete the nuclear triad for our forces. The synergy of the three services and India's future military build-up to deter the formidable Chinese will however only be suitably energised if the country goes in for long awaited defence reforms in India's higher defence management structure.

Lt Gen Kamal Davar (retd)

Three J-10s of the PLAAF 'August 1st Aerobatic team' in formation take off at Zhuhai

Pair of Su-27s of the 'Russian Knights' aerobatic team

FAST JET TO CHINA

The Zhuhai Air Show, 2012

Try as you may, it is not easy to find a 'bad' road in China and during this short stay of a week, we did not find toll booths, spinoff of the innovative Indian PPP formula, either. We landed at Zhuhai airport late afternoon on 12 November. The tarmac was crowded with participating aircraft, the static display cordoned off, with broad passages in between allowing for transit and to provide good view for the keen observers. A major section was dedicated to Chinese-built military aircraft, from First World War biplanes through the MiG-15 and upto contemporary types such as the J-10.

There were enclosures for Gulfstream, Hawker Beechcraft, Embraer and Dassault, Bombardier executive jets (including ours which belonged to India Bulls). In fact, Bombardier had four business aircraft on static display, the super midsize Challenger 300 jet, Challenger 605, the widebody Challenger 850 and the ultra long-range Global 6000 jet, featuring the new Bombardier Vision Flight Deck. Aircraft selected for flying display were lined up along the edge of the tarmac closest to the runway, well separated from the public, to allow for easy taxiing in and out. Rescue helicopters and crash teams were clearly visible. The crowd was on the west side of Runway 05/23 with the display area towards the East.

PAF JF-17 taxies out before take off

Zhuhai is a large and visibly growing coastal city in proximity of both Macao and Hong Kong. This is primarily a military airfield with a long, well surfaced runway and acres of parking space as well as hangars, thus infrastructurally well suited to host an airshow, much the same as at Yelahanka. The Zhuhai Airshow is a biennial event at which an increasingly assertive and capable China, can (and does) showcase its aviation industry and air power, also allowing international aviation industry to showcase products and conduct business with the Chinese.

The 9th China International Aviation and Aerospace Exhibition 2012, began with much fanfare on 13th morning,

parajumpers descending through a swirling pattern of colour smoke candles, streamers and massive red flags. Flying displays by fighters followed, crowned by the exotic sight of two Boeing Stearman biplanes, each with a spritely young (and brave) lady dancer strapped atop the wings.

Excited public announcements sounded very agitated and loud but were alas! incomprehensible to the non-Chinese speaking spectators. Practically all publications at the Show too were in Chinese. Pakistan was prominently present with three JF-17s of the PAF parked alongside the Chinese *August 1st Aerobatic Team* with their J-10s.

The PLA Air Force put on a splendid seven aircraft aerobatic display in their J-10s painted blue-white and red. Their manoeuveres were tight and impressive, comprising a series of loops, barrel rolls, vixen breaks and the bomb burst as finale with well timed IR flare release.

Other aerobatic teams were the Breitling team with L-39s flown by French pilots, very professional and eyecatching. The five Su-27s of the *Russian Knights* left a great visual impression with their ear-shattering performance. Needless to add the Su-27s could do everything the others did and added the manoeuvre that the others cannot or will not – a tail slide in full public view. This time around, the K-8s of the PAF's *Sherdils* formation aerobatic team were not at Zhuhai but a single JF-17 of the PAF *Black Panthers* Squadron carried out an impressive solo display.

There were other aircraft on flying display or simply landing and taking off, to keep spectators

glued. These included a light aircraft that carried out an infinite number of serial loops in a very tight diameter, the Z-10 Chinese attack helicopter that displayed excellent manoeuverability and so on.....

The first three days were essentially for official business with the remaining two days open to the public. Airborne displays were more or less repetitive, the same on all days with an eye on the weather which started to deteriorate after the second day, with low clouds and an occasional drizzle limiting both spectator visibility as well as aircraft freedom to manoeuvre, specially with hills in proximity of the airfield, both towards the east and west.

The Zhuhai Air Show conveyed the impression that "China has arrived". It was well conducted, the display management was impressive, organizers including the large number of military guards were professional, friendly and helpful and there was no trace of suppression of information or unnecessary restrictions outsiders might expect of a non democratic regime. The corollary may well be that we (in Aero India) have some catching up to do...!

Air Commodore VP Singh (retd)
(who was part of the Challenger 850 crew at the Show)

JF-17 Thunder of the PAF's No.16 Squadron ('Black Panthers') takes off at Zhuhai

The Xian JH-7 Flying Leopard is operated in large numbers by the PLA Navy

The ZW-10 attack helicopter showing its manoeuverability near the Zhuhai hills

Captain Rajesh Kumar with the Global 6000

Does India really need ICBMs ?

With successful launch of the Agni-5, India now is on the cusp of having an intercontinental ballistic missile (ICBM) capability. The Agni-5, an intermediate-range ballistic missile able to carry a nuclear warhead, has a range of 3,100 miles, 300 miles shy of becoming an ICBM, according to internationally recognised standards (a capability that so far belongs only to China, France, Russia, the United Kingdom, and the United States). But since India's supposed nuclear adversaries are China and Pakistan – both less than 2,400 miles away – does India really need an ICBM?

To be sure, the continued development and potential deployment of the Agni-5 would be a strategic milestone for the nation, one that would ideally signify completion of the land-based segment of India's strategic delivery capability. But it remains to be seen whether that milestone justifies a longer reach, whether India will pursue longer strike ranges in the form of a truly intercontinental ballistic missile capability, or whether the entire pursuit is less strategy than showmanship.

As India celebrates the Agni-5, it is worth considering the rationale of the nation's technological pursuit of intercontinental reach–and then worth examining whether the pursuit itself is rational.

India, China–and an intercontinental reach

Due to proximity, India has had the ability to strike Pakistan for years. In theory, the Agni-5's potential to hit Beijing now elevates India's nuclear deterrence status vis-à-vis China, from existential deterrence (non-use based on a fear of the uncertain destructive power of a country's nuclear arsenal) to deterrence by punishment (a strategy of threatening massive retaliation to deter enemy aggression). But does this mean India's nuclear deterrent is credible (always ready, but never used)?

Even with the Agni-5 in place, China holds a vast, asymmetric advantage over India through the sheer numerical superiority of its inventory, which has the flexibility for extensive coverage over the whole of India. In fact, China merely needs its medium-range missile (the DF-21) or its shorter-range systems deployed in its southern military regions to target Indian strategic assets or, for that matter, to deter India from even conventional forays. India, however, would need a colossal inventory of Agni-5s to deter China - and even then could suffer massive retaliation.

> India's successful launch of the Agni-V is an enormous technological achievement, but its projection as an ICBM hardly serves any strategic purpose.

Nor can New Delhi discount recent strides Beijing has made in ballistic-missile defence. In January 2010, China successfully tested a long-range exo-atmospheric interceptor, which, when deployed on a nationwide scale, might negate striking prowess of the Agni-5. India's own Prithvi Air Defence interceptor, however, is stranded at an upper endo-atmospheric capability of 30-50 miles, which might be relatively effective as long as China launched only its shorter-range or slower missiles – and even then would likely have limited efficacy. Meanwhile, in order to create a nationwide missile defence that would be effective against anything larger or faster – for example, if China were to launch intermediate-range missiles to strike the Indian heartland – India is further impeded by the absence of long-range tracking radars, which would allow it to actually test its planned exo-atmospheric interceptors.

Ultimately, with the efficacy of its missile defence remaining 'dicey', India simply does not have – nor is it ever likely to have – a missile inventory that matches China's. The task would be near-impossible: Beijing modernises its arsenal and augments its strategic forces at a frenzied pace to meet its extra-regional aspirations. (India is not the only game in town.) The Chinese arsenal is doctrinally tailored with an imposing range of platforms designed to meet all of its perceived threats, including the force of the US arsenal. This being the case, it would be imprudent to think that an Indian missile with ranges beyond 3,400 miles would have a specific utility against China. What's more, India does not have any perceivable enemy beyond the South Asian frontier that might justify an ICBM capability. Perhaps this is why proponents of Indian ICBM development rely more on intangible rationales -- like enhancing India's rising global profile -- to justify the pursuit of ICBMs.

One thing is certain: the Agni-5 launch has unleashed a frenzy of techno-nationalism. Surprisingly, Agni-5 fever was not initiated by the government, which has merely described the system as a long-range ballistic missile, but by the defence research and development establishment, which obstinately insists on calling the Agni-5 an ICBM. To many, this posturing reads as just the latest attempt by the defence research and development establishment to define India's strategic objectives and, in the process, undermine the mandate of the National Security Council and National Security Advisory Board. After all, the establishment seems eager to define and justify technological benchmarks. Previously, officials of the defence research and development organisation claimed to have achieved exo-atmospheric capability at roughly 19 miles, a far cry from the internationally accepted definition of 62 miles as the threshold of Earth's atmosphere (also known as the Kármán line, the boundary between Earth's atmosphere and outer space). Defense officials have also made clear their intent to pursue anti-satellite capability (to match the Chinese), a plan that boldly contradicts the government's position against the militarisation of outer space. Meanwhile, the defence research and development chief has declared that India will not cap missile development at 3,100 miles, a move the armed forces is expected to back, going by their obsession for power projection, a recurrent theme responsible for India's recent high-tech acquisitions. (A former Indian Air Force chief has been quoted saying that India needs a longer delivery capability to match its "sphere of influence".)

Going forward. The Agni-5 is undoubtedly a commendable technical accomplishment.

When confronted with the enormity of China's arsenal, India needs a strategic plan, not a technological one.

The system has broken new ground in terms of India's capacity to develop three-stage boosters with solid propellants and launch them from mobile platforms with over one-ton payloads. Reports also point to a breakthrough in MIRV capability. Of course, this is exactly why it is an opportune moment to enact a strategic and politically guided policy on India's deterrence intentions – before the techno-nationalists go too far. With no strategic requirements for an ICBM and insurmountable asymmetry with China, the political leadership must resist efforts to seek parity of range or numbers. The focus, instead, should be on improvement of existing delivery platforms, including the Agni-5, in order to project a realistic, formidable second-strike capability. Having fulfilled its primary objectives, the Agni-5 should be capped at 3,100 miles while work continues on its deployment system. After all, offensive forces like ICBMs could prove to be anachronistic in a security environment increasingly influenced by strategic arms reductions.

A. Vinod Kumar, IDSA

The only perceived enemy India has that is far enough away for the Agni–V's range to matter is China. But China has a decisive and commanding edge over India and is not likely to be deterred by India's newest missile.

Agni-V: India's real 'Iron Fist'

On 19 April 2012 shortly after 8.00 a.m. India entered the Inter Continental Ballistic Missile (ICBM) "Club" as India's Agni-V ICBM was successfully test-fired by Defence Research & Development Organisation (DRDO) from Launch Complex 4 of the Integrated Test Range (ITR) at Wheeler Island off the coast of Odhisha using a rail mobile launcher. The time lasted around 20-minutes (1130-seconds). The missile attained an apogee of 600-km above prior descent while the third stage fired the Re-entry Vehicle (RV), which separated at 6-km/sec and started encountering the atmosphere at an altitude of 100-km. The RV subsequently attained further acceleration due to gravity to record a speed of Mach 25+ and impacted the pre-designated target point at "pin-point accuracy", within a few (reportedly single digit) metres of the designated target point at even more than 5,000-km away in the Indian Ocean. Although the exact range of Agni-V is classified, the road mobile missile is comfortably expected to reach targets in excess of 7,000-km if armed with a single 200-kt nuclear warhead thereby obliterating any hostile targets in Asian landmass from secure launch points deep interior India. The Agni-V is expected to be operational by 2014 to 2015 after six rigorous tests including three pre-induction ones.

With a length of 17.5-metres, diameter of 2-metres and 'launch mass' of around 50-tonnes, thanks to extensive use of composites to reduce weight, the Agni-V is a three stage solid fuelled missile with composite motor casing in the second and in the miniaturised third stage. Agni-V will incorporate advanced technologies involving ring laser gyroscope and accelerometer for navigation and guidance further to be boosted by military grade precise signals from Russian GLONASS satellite navigation system. Agni-V will also carry at least three Multiple Independently targetable Re-entry Vehicles (MIRV) payloads within its 1.5-metre diameter all carbon composite RV (Capable of withstanding temperatures of up to 5,000-degrees Celsius) to deliver multiple manoeuvring warheads at different targets or on a single target to execute saturated strike to overwhelm enemy Ballistic Missile Defences (BMD). A sea launched variant with a length of less than 12-metres may be anticipated for ballistic missile armed nuclear powered submarines (SSBN) that may in peacetime double as Satellite Launch Vehicle (SLV) fired from proximity of the equator to put multiple satellites in geo-synchronous orbits with ease. Agni-V is poised to emerge as India's standard ballistic missile to be put to mass production to ensure assured deterrence in foreseeable future with the predecessors holding fort until about 2018. The stunning accuracy displayed by the Agni-V prototype, along with extensive mobility and indigenous BMD will enable India for the first time to adopt a 'limited deterrence' posture by adopting both counter force and counter value stance.

Finally the matured response of major global powers in response to India's ICBM test has affirmed India's position as a responsible nuclear weapons State with self-imposed non-proliferation obligations. The test also reduced Peoples Republic of China's (PRC) long time dream to dominate the Asian landmass in due course. It is also high time for the Indian scientific community to conduct a couple of round of nuclear weapons tests to fine tune the thermonuclear devices to be mounted on Agni-V. A promise of signing Comprehensive Test Ban Treaty (CTBT) thereafter will certainly ensure global acceptance.

Sayan Majumdar

Flanked by MoD officials, Mr RK Mathur, Secretary Defence Production (second from right with Mr Sitanshu Kar on his left) at the Aero India 2013 'curtain raiser' in New Delhi.

Ninth edition of the biennial *Aero India International Exhibition on Aerospace, Defence & Civil Aviation* takes place at Air Force Station Yelahanka (Bangalore) from 6 to 10 February 2013 organised by the Defence Exhibition Organisation of the MoD with FICCI as partners this time.

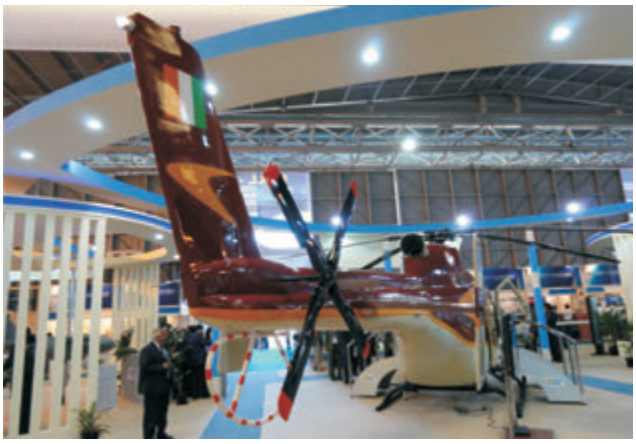
In his brief during the 'curtain raising' conference at DRDO Bhawan, New Delhi on 21 January, Mr RK Mathur, Secretary for Defence Production gave an overview wherein the objective remained "to generate business for both products and services, expose our own armed forces to the latest developments in the world of defence aerospace, introduce general public to the industry, inspire young people who might make aerospace their profession". Mr Mathur was flanked by Mr AK Gupta, the Additional Secretary, Ravi Kant JS (Missile Systems), Mr Sitanshu Kar, Additional DG (M&C), Wg Cdr MD Singh of the DEO and Mr Rajan Kohli from FICCI.

Seen at Aero India 2011, various US aircraft types including the F-16, F/A-18, and C-130 Hercules

Concerning participation in 2013, some 352 foreign companies are participating amongst the total of 607 while there will be 52 aircraft at the Show this time, 20% fewer than previously. This can be directly attributed to finalisation of the MMRCA programme: wherein in 2011, all six competing companies had their aircraft present this time, only the Dassault Rafale will show off its attributes, with three examples expected.

Other aircraft at Yelahanka 2013 would be the Boeing C-17 Globemaster III and individual types from Embraer, Bombardier, Lockheed Martin, Eurocopter apart from the three formation aerobatic teams. The most dramatic entry at Aero India are Su-27Ps of the 'Russian Knights', whose formation aerobatic display will be followed by Zlin 50s of the 'Flying Bulls' and Dhruv ALHs of the IAFs 'Sarang' team. The Indian Air Force will have the largest number of aircraft, both on static and flying display with their chalet first in the row of 72 such special structures facing the runway, a vantage point to view aircraft taking off and landing.

DRDO have largest display, both indoor and outdoor, followed by HAL, BEL and the Tata Group. Amongst foreign exhibitors the largest indoor display are by



Full scale mock up of HAL's light utility helicopter in Hall E during the last Show.

US Companies while EADS have the largest outdoor display. There are ten country pavilions including those from Italy, Israel, Russia, Germany, France, the UK and Ukraine while other participating countries include Australia, Japan, South Africa, Spain, Switzerland, Canada, The Netherlands, Brazil, Singapore, Sweden and the UAE. 78 official delegations are expected and a number of these will also be attending the Aero India 2013 International Seminar, inaugurated by Defence Minister AK Antony a day earlier, on 5 February although various speakers would have made their presentations from the day earlier at the Nimhans Convention Centre in downtown Bangalore.

Boeing C-17 Globemaster III at Aero India 2009

Upgradation of the Mirage 2000H/TH

Two IAF Mirage 2000s (KF-103 and KT-207) are presently being upgraded to the new Mirage 2000-5 Mk.II standard in France, while the balance Mirage 2000s in IAF service will be upgraded in India at the Bangalore Complex of Hindustan Aeronautics Limited. The first two Mirages are scheduled for return to India from France in late 2014, with balance upgraded Mirage 2000s to be delivered to the Indian Air Force within seven years.

After several years of discussion and negotiation, the Government of India had contracted to upgrade the IAF's fleet of 51 Mirage 2000H/TH in a major programme involving Dassault Aviation and Thales. This was officially signed on 29 July 2011 and commented upon as follows : "Based on the integration of latest generation equipment and systems, the upgrade will further enhance the technical-operational capabilities of the Indian Air Force's Mirage 2000. The aircraft represents a long tradition of cooperation with French military aviation, initiated 50 years ago,"

Among the upgrades planned for the IAF's Mirage 2000 are a night vision goggle-compatible glass cockpit, advanced navigational systems, advanced Identification Friend or Foe (IFF) system, advanced multi-mode multi-layered radar, fully integrated electronic warfare suite and advanced beyond visual range (BVR) capability. The new weapons include 450 MICA interception and aerial combat missiles. Thales and MBDA, will be the weapons systems integrator and missiles supplier respectively.

The IAF Mirage 2000 upgradation is reportedly based on the Mirage 2000-5 Mk.II standards, the most advanced variant of the aircraft. Enhancements to offensive systems included a datalink for the targeting of MICA ER missiles, the addition of the Damocles FLIR targeting pod and a newer, stealthier Thales RDY-2 all-weather synthetic aperture radar with moving target indicator capability, which also grants the aircraft improved air-to-ground capability.

The avionics are to be further updated with higher resolution colour displays, an optional Topsight helmet-mounted display, and the addition of the Modular Data Processing Unit (MDPU) as designed for the Rafale. A new Thales Totem 3000 inertial navigation system with ring laser gyroscope and GPS capability is added, providing much greater accuracy, higher reliability, and shorter alignment time than the older ULISS 52 navigation system which it replaces. Other upgrades to be included are addition of an on-board oxygen generation system (OBOGS) for the pilot and an ICMS 3 digital countermeasures suite.

Photos by Angad Singh

"An Energised Aerospace Industry"

Air Marshal RK Sharma

Air Marshal RK Sharma, then Deputy Chief of Air Staff IAF (now AOC-in-C Eastern Air Command) urges the "Energising of India's Aerospace Industry" *

As stakeholders we are all committed to "energising the Indian aerospace industry", which I am confident is poised at the threshold of a steep 'growth trajectory', since it is now increasingly being recognised that the aerospace sector has a significant bearing in the overall economic activity of a nation.

Today the *Energy Drivers* for growth of the Indian Aerospace Industry are largely in place – both in terms of demand and policies. Now, it is also time for the industry to act with commitment and drive. The window of growth in consort with the Air Force will be there for about the next 15 years. This opportunity must be seized.

To explain this specifically the defence aerospace industry depends heavily on what the defence forces want, largely the Air Force. The Indian Air Force is today on the path of rapid transformation, both in terms of modernising its assets and a

ADA-designed, HAL-built Tejas Light Combat Aircraft

*** Keynote address at the 7th International Conference on 'Energising Indian Aerospace Industry : Emerging Opportunities, Enduring Partnerships' at New Delhi (CAPS and CII) on 20 September 2012.**

strategic orientation that extends beyond the country's geographical boundaries. The Government has strongly supported our modernisation drive by providing increased budgetary allocation year on year for capital acquisitions in consonance with our modernisation plan and core interests. Majority of these acquisitions for modernisation of IAF will take place in the 12, 13th & 14th plan periods (2012-2027).

The Government (of India) has taken several policy measures to energise the aerospace industry. These energy drivers, if I may say so, have made investments by the private sector into aerospace industry attractive. The introduction of Offsets and the recent refinements to the policy, is perhaps one of the most important such enablers. Similarly changes in the Procurement procedure have created a better environment for the private sector to participate in procurements. Major global aerospace players have recognised this opportunity and are taking steps to consolidate their interest in our country. This will further fuel growth. Offsets have further catalysed the formation of several joint ventures that promise to bring in advanced technologies and best industrial practices to India. Thus, the environment is conducive and it is time for industry to take benefit of these energy drivers and harness the huge potential that the aerospace sector offers.

So, where are we today ? The Indian Air Force is largely dependent on core competencies of the Defence Public Sector undertakings, which units have evolved into large and capable orgnaisations. Modernisation drive of the Air Force has resulted in placing of substantial orders on these entities. Ample scope continues to exist for the Private sector to participate either along with the DPSUs or even independently. The DPSUs/DRDO must not view the private sector as competitors but instead help them integrate into this sector. In fact, the success of this drive for growth of our Aerospace sector would depend on support and guidance from the DPSUs and acceptance of the private sector as "equal players".

The Small and Medium Enterprises constitute an important element of the supply chain network for any developed aerospace industry. However, owing to limited financial resources, SMEs require institutional or Government support to thrive. The latest trends are certainly encouraging. It is heartening to note that some of the SMEs are doing very well in the aerospace products and participate in our acquisition process with a lot of enthusiasm.

I am hopeful that forums such as this conference would help the industry focus on what they need to do in the immediate future as well as in the long term to boost their growth. You all are experts in your field and eminently capable to analyse the way forward. However, I would like to bring to attention some important focus areas for implementation :

- an important element is to overcome 'risk aversion' and make serious effort for full scale involvement in aerospace ventures. There will be some gains and some losses but the will to plod on must remain.
- the industry must push for joint ventures and collaborations as sustainable business ventures and not merely to corner offsets. This is a good time, because shrinking global economy would encourage many aerospace majors to willingly share technology and support setting up of the state-of-the-art manufacturing facilities.
- there is a need for the private sector to liaise with major DPSUs and DRDO to share their infrastructure and specialist facilities rather than duplicate them. Surely some arrangement can be worked out whether at cost or otherwise.

HAL is developing the HJT-36 Sitara intermediate jet trainer


56 numbers of the Avro (BAE) medium transport aircraft with the IAF are sought to be replaced in a unique private sector/foreign collaborator venture.

- to be successful in the long term, one will need to commit resources to create appropriate infrastructure; promote training and R&D. Innovative collaborations with established DPSUs and global players, in these fields, must be targeted.

Another important factor associated with growth of the aerospace industry is the synergy between military and civil aerospace sectors. Economy of scales dictates that both 'big and small' or 'public and private' players must cater to both the markets to remain economically viable and competitive.

Then, Maintenance Repair and Overhaul (MRO) is an area that could become a major growth driver for India's aerospace industry. Small steps have been taken in this field both for civil and military products. There is no reason why India cannot become a major civil aviation MRO Hub for South and South East Asia. Projections by well known research groups and aviation majors paint an optimistic picture for the growth of regional civil aviation in India. The demand for MRO facilities with country could surpass the capacity.

Coming back to defence needs, I had posed this question earlier too as to, why cannot the private sector take on manufacturing of weapons, Electronic Warfare systems, and other strategically sensitive products ? After all, elsewhere in the world, these are being manufactured in the private sector from whom we also procure our requirements. Surely we can trust our own to deliver too !

Some challenges ahead

Irrespective of the environment and the drivers, there would be challenges ahead : first and foremost, for our aerospace industry to take on the task of meeting the needs of the Air Force, strategic aspirations of the private sector must align with Government policies and procedures.

Defence, and especially aerospace D&D and production, have historically suffered from severe timeline slippages. The Air Force is most concerned with cost and time over runs, quality control, reliability and product support. We have suffered much on this count in several of our indigenous projects and the industry must factor this as a building block, right from the word 'go'. I must flag this as a crucial challenge. For our industry to be globally competitive, these aspects must be respected. We will into be able to modernise ourselves at the desired pace if these issues critical to the Air Force are not given strong attention.

While internal demands of the defence forces and the civil sector promise to grow, aerospace companies have to build an export market for enhancing their commercial viability. Selling products in the world aerospace market, that is already long captured by global majors, will be a real challenge.

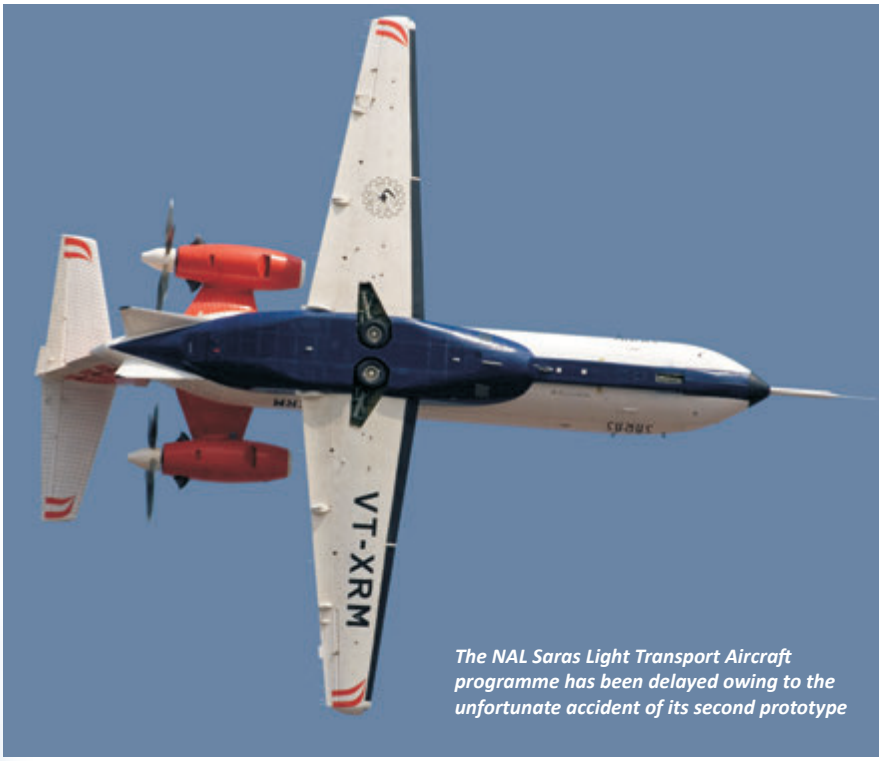
Manufacturing, testing, QA and supply chain management, all require highly skilled work force and on-job experience which becomes an essential pre-requisite. Retaining such talent pool would always be a challenge. We may be able to buy technology and machines to manufacture but it is difficult to hire skilled and experienced workers from outside.

As a long term challenge, the growing need for a skilled work force brings out the associated need for enhancing the number of aerospace technology education centres. While we do have some 'centres of excellence' in aerospace education and research, we would need to enhance capacities and make it attractive for the young bright people to join, and thereafter stay on in the aerospace sector.

I would reiterate that we stand today at a critical juncture in our quest for a strong aerospace industry. As India rolls into the future, striving to become a major global player, the aerospace industry would play a significant role in enhancing self-reliance. For emerging players there is no harm in considering procuring off-the-shelf technologies which are easily available and focus on developing core technologies that are hard to get. Established aerospace DPSUs and the DRDO must shoulder responsibility by providing access to their

Prototype of the HAL Light Combat Helicopter (LCH)

AVI-OIL



The NAL Saras Light Transport Aircraft programme has been delayed owing to the unfortunate accident of its second prototype

infrastructure, domain knowledge and guidance to the private sector – big and small. This sort of Public-Private partnership is essential to move along the self-reliance trajectory : the larger national objective dictates this as an imperative.

The Government would continue to support the aerospace sector by removing perceived 'growth barriers' and adding 'growth drivers'. We hope that in not too distant a future, aerospace industry would become one of India's driving constituents of the national economy, while boosting the operational potential of the Indian Air Force in a more sustainable manner. It shall be the Air Force's endeavour to ensure that we continue to play an important role in helping the domestic aerospace capability establish itself with appropriate 'hand holding'. Having said that I will underscore that the Defence budget is under a lot of pressure and we in the Air Force will demand value for money. As advised earlier, the provide industry must adopt best ethical practices and be extremely sensitive to the Air Force's concerns on or security of information. On our part, we assure a standard yard stick for all players along with probity and transparent dealings.

Undoubtedly, in the time to come, an 'Indigenous, Energised but an Efficient Aerospace Sector' would became a strong pillar of national security and economic strength.

Even as the Indian Air Force phases out its large fleet of MiG-21s and MiG-27s, an increasing number of HAL-assembled Sukhoi Su-30MKIs are being delivered.

Elettronica

Energising India's Aerospace Industry

Developing indigenous regional airliners

Computer generated images of the NCA-90 (top) and RTA-70 regional airliners

Some 17 years ago, when inaugurating Aero India 2006, the then Prime Minister Deve Gowda announced two 'gifts' for the indigenous aircraft industry and Karnataka : read Hindustan Aeronautics Limited and Bangalore respectively. The PM went on to specify that two categories of civil airliners would be "designed, developed and produced by HAL", being 50- and 100-seaters. Notwithstanding this formal announcement by India's Chief Executive, neither programmes actually proceeded, inspite of an agreement for the first, smaller airliner, with a chosen foreign OEM.

The Franco-Italian aircraft manufacturer ATR (*Aerei da Trasporto Regionale or Avions de Transport Régional*) was to be the partner but HAL did not, or was not cleared to, proceed and inspite of the potential requirement for over one hundred of these 40-70 seaters, no headway was made. As it turned out, nearly one hundred ATR-42s and -72s were thereafter imported by various national airlines, and these have since been operated on scheduled services over 15 years later, with scores of routes criss-crossing the sub-continent.

As for the 100-seater, this was a complete non starter. In fact, there appeared in 2002-03 a fantastic opportunity for HAL to acquire the futuristic Fairchild-Dornier 728 and 928 programme for 70-110 seaters at virtually give away prices. This was consequential upon the erstwhile German company (with US ownership) going into receivership at a time when this regional jetliner was well ahead of its Canadian and Brazilian competitors. Had the 728 / 928 programme proceeded, Lufthansa was to be launch customer with over 150 ordered and Jet Airways in India would have been the first Asian operator of this superior technology and high performance jetliner.

However, this was not to be. Then some five years later the Government of India once again suggested that the National Aviation Industry work towards developing civil airliners. On 23

The RTA-70 turboprop would aim to have 25-30% lower flyaway and direct operating costs.

September 2008, selected personalities which included scientists, industrialists and operators met with the Minister of Defence to initiate an ambitious project to develop and manufacture civil regional aircraft. The mission would be to make "a cheap, rugged and easy to maintain 70 to 110-seater civilian aircraft that should start rolling out within a decade".

Still, there was no decision or direction on aspects such as work share, funding and whether the aircraft would be turboprop or turbo-jet powered. "It is too early for these details. The team entrusted with such task will soon come back with a detailed project report," said the MoD spokesman at the time.

The original intention was to develop a 70-seater turboprop-powered airliner, identified as the RTA-70 to meet specific needs in the country for short-haul flights, as also with an export potential. According to industry estimates, there would be a worldwide requirement for more than 3000 regional airliners in the 50-90-seat category, to replace current fleets with ATR 42/72s, Bombardier Dash 8s, Fokker F27/50s, HS 748s, Saab 340/2000s, Antonov An-24s and others. The RTA-70 design approach was ambitious in that it would aim for some 25-35% lower flyaway and direct operating costs than contemporary aircraft.

A first meeting was held on 29 February 2008 with the Directors and senior scientists of various laboratories/ institutes of the CSIR, DRDO and DAE, to appraise various R&D organisations of the technology needs of the Regional Transport Aircraft. Former head of the LCA project, Dr Kota Harinarayana, who had joined NAL as a *Raja Ramanna Fellow* was to spearhead the Regional Transport Aircraft project. He presented an overview and detailing the need for a new generation aircraft based on market demand for an aircraft with low fuel burn, ownership and maintenance costs. Key technologies would be in the area of a laminar flow wing, hydrophobic coatings, use of low cost composites, fly-by-wire controls and advanced avionics plus integrated aircraft health monitoring systems. Presentations from NAL scientists and consultants of the RTA group then followed on aerodynamics, super hydrophobic coatings, morphing and the use of SMA for high lift devices and maintenance for civil aircraft. For the airframe, presentations on structural technologies required, use of piezo and SMA related smart materials for flutter and gust control, structural topology, structural health monitoring (SHM) and low cost composites were made. Architectures for avionics, active noise control systems flight control systems (fly by wire) and synthetic vision were described. Utility systems including ECS, all electric systems etc, were also presented.

In August 2008, the former President of India Dr APJ Abdul Kalam pronounced that "India can produce small passenger jets by 2020 !" But for this, India needed to make optimum use of its technology in the aerospace sector. Dr Kalam was addressing a gathering of students at Amity University in Noida. "India has to work for 70-seater aircraft. It should be so designed that with only change in fuselage length it could vary the passenger capacity to 50 or 90 … with the technology available, production of 70-seater passenger aircraft before 2020 is possible. This will lead to a business volume of $15 billion".

It was announced in December 2009 that the Indian Space Research Organisation (ISRO) would be part of a consortium led by NAL as the nodal laboratory but would be run by an independent commercial body, with public and private partners, including an overseas aerospace firm. According to Dr. CG Krishnadas Nair, President of the Society of Indian Aerospace Technologies and Industries (SIATI), "once approved, the project will take around six years to build and the aircraft certified".

The turbofan-powered NCA-90 regional jetliner.

"HAL will be the manufacturing partner and firms such as Infosys Technologies and the local unit of US technology firm Honeywell International will be building some technology components," stated Dr. Satish Chandra, Head of the RTA programme at NAL. The RTA-70 was to be "capable of reliable and safe operation from airports with minimal infrastructure and instrumentation facility under all-weather conditions." The period from

development to certification was estimated to take some six years and rather grandly, it was announced that India would join a select group of companies manufacturing 70 to 110-seater jets, including Embraer, Bombardier, Mitsubishi, Sukhoi and AVIC of China.

However, after the initial approach to develop a 70-seat turboprop airliner (RTA-70) at NAL, the High Powered Committee (HPC) set up in April 2010 selected a turbofan-powered airliner of 90-110 seats instead to be called the NCA-90. Matters moved apace, as indicated in the high level meeting of 23 September 2010, which reflected the Government's seriousness in pursuing the proposal whose development cost has been pegged at Rs 4,000 crore. Those at that session included Principal Secretary to the Prime Minister TKA Nair, Defence Secretary Vijay Singh, Civil Aviation Secretary M Nambiar, CSIR Director General Samir Brahmachari, Space Commission Chairman Dr Madhavan Nair, Dr Kota Harinarayana, Dr Krishnadas Nair and Dr AR Upadhya from National Aerospace Laboratories, Dr PS Subramaniam of the Aeronautics Development Agency, Chairman (HAL) Ashok Baweja and representatives from the Defence Research & Development Organisation and the lone 'civil aviation' representative, Air India.

The meeting concluded with the statement that "India has the technical base as also the resources to develop an aircraft of this size for both domestic and international markets." To be called the *Indian Regional Transport Aircraft*, this programme was supposed to "reduce import dependence to a considerable degree. It is estimated that India will require over 1,200 of such 70-100 seater aircraft by 2026. Most members at the meeting felt the environmental performance of the aircraft in terms of noise and emissions must be the main criteria for this to make an impact on the international market".

A design bureau was set up at NAL with an increasing number of select engineers, which eventually numbered 40. After working on conceptual and feasibility studies, the Study Report was submitted to the DG-CSIR on 20 May 2011 by the 16-member High Power Committee (HPC). This was followed by detailed discussions with the Minister of Science and Technology in July 2011 as also Members of the Planning Commission, Dr Kasturirangan and Mr Arun Maira and, in August 2011, with the Deputy Chairman of the Planning Commission Dr Montek Singh Ahluwalia.

The Council of Scientific and Industrial Research (CSIR) formed JV and Technical Committees to begin discussions with the Indian private sector to form a consortium on the lines of the European Air & Defence Systems (EADS) or even the Sukhoi Holding Group. The Joint Venture Committee was chaired by Dr Vijay Kelkar, former Finance Secretary with Mr Shyam Chetty, Director NAL as Member Convener. Amongst the private sector companies invited to the discussions and presentations were the Tata Group, Mahindra & Mahindra, Taneja Aerospace (TAAL) and the Piramal Group.

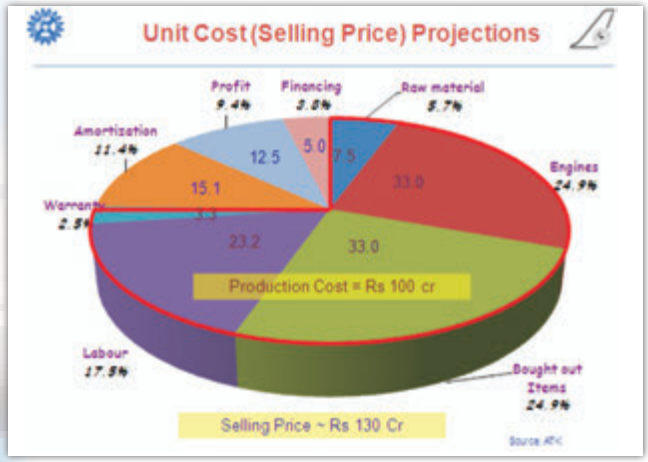
The JV Committee's terms of reference were to identify industry partners through a transparent exercise and work out the modalities for the JV formulation, suggest equity structure, and give necessary inputs to CSIR for developing a Cabinet note for obtaining in-principle approval for implementation of the programme, as recommended by the Planning Commission. In principle approval was sought for Rs 4,500 crores for the development phase and another Rs 3,000 crore as production start up costs.

Matters thereafter seem to have slowed down and this has been attributed to certain differences on choice of the nodal ministry : Ministry of Civil Aviation or Science & Technology ? This is somewhat curious as the Planning Commission had vetted the entire report and even Prime Minister Manmohan Singh was "highly impressed". Should the programme be cleared by 31 March 2013, enabling the NCAD to proceed with the programme, the first NCA 90 prototype would well have made its maiden flight in 2017-18 but this now looks most unlikely. According to Mr Shyam Chetty "there are many policy issues that need to be ironed out and since this programme involves a large amount of money, will take some time before we get clearance".

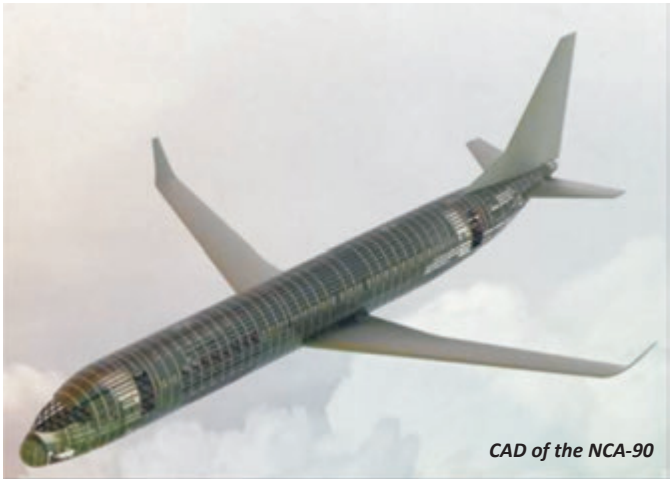
On the key issue of international and private sector participation, Shyam Chetty is quoted as querying on "how do we finance a programme with large public sector funding, but larger private sector participation ?".

India's aerospace industry and the Airlines await the answers.

With extracts from the paper presented by Mr Shyam Chetty, Director CSIR National Aerospace Laboratories (NAL).



Sources : NAL



CAD of the NCA-90

The Gripen NG programme is evolving into an affordable 4+ generation multirole combat aircraft

75 years of Saab : into the new millennium

The well known and highly respected Swedish Aerospace Company Saab marked its 75th anniversary in 2012, commemorating this landmark event with a four-day long programme at Linköping, Sweden. In addition to the celebrations then, the Company has recorded many positive factors , both at home and abroad.

The flagship Gripen NG programme achieved several key milestones, including a well-publicised appearance at the Swiss live-fire demonstration at the Axalp firing ranges in October. The Swiss have selected the Gripen NG (now known as the JAS 39E/F) as their future fighter of choice, influenced in no small part by the type's stellar performance in the Libyan skies during the UN-mandated Operation Unified Protector. This continues a trend that has the Swedish defence company earning more revenue from international sales. The home front is just as healthy, with the Swedish parliament having voted in December to acquire 60 Gripen E/F fighters as well, thus securing the future of the type's development. The Gripen E (single-seat) prototype is programmed to fly in the second half of 2013.

Saab is also working on other aviation areas, and in 2012 launched a maritime surveillance aircraft based on its Saab 340 turboprop. This aircraft has joined the highly competent family of reconnaissance and surveillance aircraft based on the Saab 2000 and Saab 340 airframes, including the Saab 2000 Erieye, Saab 340 Argus, and Swordfish MPA among others.

Saab's traditionally independent heritage has not blunted its ability to be a global partner, and in 2012, it renewed a contract to supply parts to Airbus, as well as forged an alliance with Indian firm QuEST Global Manufacturing.

Unmanned aerial systems are also on the portfolio of the Swedish manufacturer, notably the Skeldar programme, a rotary-wing UAV intended for tactical reconnaissance at sea as well as on land. Saab has 25% responsibility for the pan-European nEUROn unmanned combat air vehicle (UCAV) made its first flight in December 2012, with further testing planned in France over the next two years, at which point it will move to Sweden for operational trials. The nEUROn is a stealthy UAV with long range and the ability to deploy precision guided munitions.

The Skeldar rotary UAV

Beyond the successes of 2012, Saab is preparing for the new year with optimism, confident of greater achievements as a known producer of on-budget, on-time products in an era of shrinking defence budgets.

The Saab 2000 AEW&C aircraft with Erieye

Russian Air Force augments Yak-130 fleet

Russian Air Force cadets will start to train on Yak-130 new generation training aircraft from March 2013. In a statement issued by the Russian MoD spokesperson on the eve of Aero India 2013, Irkut have completed their contractual obligations for the year 2012 in the delivery of fifteen Yak-130 combat trainers to the Russian Air Force, under a contract for 55 aircraft to be supplied to the Russian AF by 2015. The formal contract, between the Russian MoD and Irkut Corporation was signed at the end of 2011.

The Russian AF envisage acquisition of at least ten additional Yak-130 trainers up to 2020 and several Russian officers have also articulated their plans to form a new pilot group, which will fly Yak-130 aircraft. Overall requirements for the Yak-130 in Russian AF service have been assessed at around 250 aircraft.

As earlier stated by the Russian MoD, the replacement of L-39 jet trainers with Yak-130s was dictated by the necessity to provide lead-in fighter training for Russian pilots for operation of new generation Su-30SMs and Su-35s, which are now entering service with the Russian AF. Considering that these technically advanced aircraft as well as the Sukhoi T-50 fighter generation fighter, developed in collaboration with India, are high-speed super-manoeuvrable aircraft, the Russian AF believes that its current fleet of L-39 jet trainers is "not appropriate" for fast jet pilot training because of low engine thrust, limited maneuverability and obsolete avionics.

The Yak-130, in relation to trainers of previous generations (in its capabilities and flying performance) corresponds more closely to fighters of '4++' and '5th' generations. In particular, the Yak-130's fly-by-wire system sustains controlled flight at high angles of attack and is capable of simulating the flight characteristics of a number of combat aircraft and so providing highly relevant air combat training.

Despite the Yak-130's flight certification which was completed as recently as 2009, the jet trainer has already attracted international customers. In 2011, Irkut supplied fifteen Yak-130s to Algeria, where they are being used to train pilots for operation of advanced Su-30MKI(A) fighters. In December 2012, the Belorussian Air Force placed an order for four Yak-130, and interest in the aircraft has been expressed from a number of other nations, including Kazakhstan, Vietnam and the Philippines.

In terms of performance, the Yak-130 is comparable with the AleniaAermacchi M-346, both aircraft types having been designed on basis of the Yak/AEM-130 prototype, which was constructed in Russia and had been tested in Italy during the 1990s. Therefore, the two aircraft type have been independantly developed by their respective manufacturers and differences between the Yak-130 and the M-346 outlined by British test pilot Peter Collins, who flew the Yak-130 in May 2012. "Both look similar externally, but the M-346, which I evaluated in 2006 took the route of Western avionics and engines to become a pure advanced trainer. The Yak-130, by comparison, has become not only a similar advanced trainer but also a true combat trainer." (see Vayu V/2012 for test flight review)

In the middle-term perspective, Irkut envisages the supply of 450-500 Yak-130 trainers, both to the Russian AF well as to international operators.

Russia appears to have taken the lead in advanced jet combat trainer aircraft for lead-in fightertraining. Development of this market is logically connected with the fact that trainers of previous generations cannot adequately represent performance of contemporary as well as future combat aircraft. In fact, the Yak-130 is can deploy a wide range of guided weaponry, having a total payload of 3 tonnes.

Mr Oleg Demchenko, President of Irkut Corporation, who has personally contributed to the Yak-130 development, believes that the programme has been "successful and promising", especially in view of the large-scale contract with the Russian AF. Peter Collins summed it up succintly: "Russia has got the Yak-130 almost perfectly right and, for many countries, this training and fighter aircraft could come close to providing a one-type, 21st century air force."

"CAE is positioned to help OEMs meet offset obligations"

VAYU Interview with

Ananth Ramaswami, Managing Director, CAE India

***VAYU**: What steps have CAE initiated to capture business generated by offsets in India ?*

Ananth Ramaswami: In 2012, CAE and Rossell India Limited established a special purpose company called CAE Rossell India Limited to address needs of the market generated by offsets. This company is owned 74 percent by Rossell and 26 percent by CAE. We want to maximise business opportunities as well as technology transfer to India by leveraging CAE's breadth of simulation technologies in line with the offset policy. Our discussions with major OEMs from the US, Europe, and Russia involve myriad ways in which to partner with them and help them meet offset obligations.

***VAYU**: How do you view the opportunities for simulation and training in India?*

Ananth Ramaswami: CAE firmly believes that the increased and more efficient use of simulation is part of the solution to lowering costs without sacrificing readiness or capability, and we believe India's defence forces need to augment employment of high-fidelity simulation and training systems. Simulation offers a number of benefits, notably safety and cost advantages, which simply cannot be ignored. The increased cost of fuel, environmental impacts, and significant wear and tear on weapon systems, all point to the greater use of simulation. More importantly, simulation is the ideal tool for mission preparation and rehearsal, which is critical for ensuring readiness both safely and cost-effectively.

Therefore, we see a bright future for simulation and training as there is no shortage of opportunities globally and particularly here in India. Some sections of the global defence market are facing some very real and challenging fiscal restraints, while others like India have plans for growth in defence. In either case, defence forces are not going to accept anything that jeopardises safety or readiness. The people in uniform all over the world are highly professional and they have high expectations to not let readiness be impacted even under austere budget environments.

***VAYU**: What fresh developments are required in the Indian context in order to shift a higher volume training to the virtual domain?*

Ananth Ramaswami: Making the shift to more virtual training is not without investment and certainly not without challenges, the greatest of which may be a change in behavior and approach. India's defence forces need to be ready and willing to conduct their business with a fresh perspective. For example, India needs to consider training options such as government-owned contractor-operated or contractor-owned contractor-operated training centres, such as the HATSOFF helicopter training centre in Bangalore. As a company focused exclusively on modelling, simulation and training, as well as a company that owns and operates more than 40 training centres worldwide, where over 100,000 civil and military crew members train annually, we have relevant experience both in developing world-class simulation technologies and applying those technologies efficiently and effectively.

***VAYU**: What is the progress at HATSOFF, the helicopter training centre CAE established with HAL?*

Ananth Ramaswami: The Helicopter Academy to Training by Simulation of Flying (HATSOFF) is the first and only facility of its kind in India for rotary wing training. It is a state-of-the-art training centre developed in collaboration with HAL. Currently, HATSOFF provides comprehensive training for three helicopter types, namely the Bell 412/212, civil/conventional Dhruv and Eurocopter AS365 Dauphin. From 2013 onwards, HATSOFF will add training for the military variant of the Dhruv. Utilisation of the facility is picking up and we are continuing to promote the many advantages of helicopter simulator training. The fact is that until HATSOFF was established in India, the country lacked adequate helicopter simulation training and most operators were relying on training in the actual aircraft.

Another pertinent point is that the authorities have not enforced the regulation that every commercial pilot, be it fixed or rotary-wing, must fly a minimum of 10 hours annually on a simulator. CAE is a strong proponent of global efforts by the International Helicopter Safety Team (IHST) to reduce helicopter accident rates by 80 percent by the year 2016, and according to the IHST, one of the most effective ways of doing so is the increased adoption of simulation-based training. Considering planned acquisitions and the growing demand for helicopters in the military and civil sectors in India, there will certainly be a need to augment the existing capacity of helicopter simulators in the country. CAE is very open to expanding HATSOFF as well as establishing additional helicopter training facilities in India.

AIRBUS

CAE Medallion P8A. CAE has experience developing training systems for many of the platforms being acquired by India, such as the P-8 and A330 MRTT and has established CAE Rossell to help OEMs meet offset obligations.

VAYU : What emerging technologies are likely to impact on the future of simulation?

Ananth Ramaswami: One of the definite trends we see globally is the desire to use simulation for mission preparation and rehearsal, which is critical for ensuring the readiness of defence forces. Another trend is the continuing desire for realism – in other words, to make the virtual world look and feel just like the real world. There are many pieces in this puzzle, some that are in CAE's control and some where we are leveraging the technology curve of other industries, such as gaming technologies or display technologies. Amongst the emerging technologies, the one which is capable of impacting the future of simulation, is something we call a "dynamic synthetic environment". CAE has had an internal research and development programme over the past couple of years aimed at making synthetic environments dynamic, persistent, open and scalable. Our military and defence customers have been telling us that they need a fully correlated, interoperable and persistent dynamic synthetic environment. What defence forces want to do is to have the ability to plan for missions using "what-if" analysis and decision-support tools, rehearse for missions in real-time, and then execute missions that will leave less room for surprise outcomes. Essentially the idea is to accomplish this in simulated environments which are an exact replica or 'real time' situation that the forces are likely to encounter. In other words, the synthetic environment needs to be more like the real world, which is constantly changing. This kind of integrated, interoperable, immersive synthetic environment is also important for joint, coalition training, which will increasingly need to be done in a virtual environment because of the cost efficiencies it can deliver. We will be demonstrating the Dynamic Synthetic Environment in our booth during Aero India 2013.

Elbit Systems develop C-MUSIC aircraft protection system

Elbit Systems C-MUSIC (Commercial Multi-Spectral Infrared Countermeasure) system has performed a series of successful flight tests onboard a Boeing 707 aircraft. The system, designated to protect large jet aircraft against shoulder-launched missiles (MANPADS), "was proven effective".

With the threat of MANPADS (ground to air heat seeking man-portable missiles) increasing over the last few years. Elbit Systems Electro-optics Elop's Multi Spectral Infrared Countermeasure (MUSIC) systems have developed DIRCM (Directed IR Counter Measures) solutions. These systems integrate advanced fibre laser technology together with a high rate thermal camera and a small, highly dynamic mirror turret to provide effective, reliable and affordable protection to all types of aircraft and under all operational conditions. Designed in an open architecture, the systems can be integrated on any type of aircraft. Elop's systems are under production for several programs around the world – for a large variety of military, VIP and commercial aircraft. Elop's DIRCM solutions include the MUSIC for the protection of helicopters and small to medium fixed-wing turboprop aircraft, J-MUSIC for the protection of large aircraft (heavy transporters, tankers VIP jets, etc.) and C-MUSIC which is a complete self protection solution (including the J-MUSIC DIRCM and the PAWS IR Missile warning System), installed in an aerodynamic pod and especially designed for the protection of civil and VIP large jets.

Elbit Systems/Elop long-range observation systems

Elbit Systems' subsidiary Elop will supply long-range observation and target acquisition systems to the Israel Ministry of Defence. This contract is follow on to an order received in 2011 for the development and production of mobile observation and target acquisition systems for the Field Intelligence Corps. Since then, the systems have already been deployed operationally with recognition for their high-quality performance.

As Adi Dar, General Manager of Elop, noted: "These unique systems are considered as world leaders. Light-weight and capable of performing high-quality observation in day, night and low visibility conditions, they have generated significant interest among international customers. The current contract with the IMOD further positions Elop as a world leader in the electro-optic field, and I trust that further international customers will follow the IDF and select this advanced system."

Maiden flight of first AW139 Helicopter assembled in Russia

HeliVert, the joint venture between Russian Helicopters and AgustaWestland have announced the successful maiden flight of the AW139 helicopter assembled in Russia. On 18 December 2012, the first Russian-built AW139, with tail number 60001, was rolled out at the Helivert assembly plant to perform ground testing. On the following day, 19 December at 16:30 Moscow time, the test programme continued with the helicopter's first lift-off and controlled hover. The new helicopter remained in the air for 37 minutes and completed the scheduled tests approved by Russia's aviation authorities.

The AW139 is continuing the flight test programme and the second aircraft (60002) to be assembled by HeliVert is expected to fly by end-February 2013.

HeliVert is located within the Russian Helicopters' National Helicopter Building Centre in Tomilino, Moscow region. The newly constructed plant is one of the most advanced facilities of the kind in Russia. According to plans, production of AW139 helicopters in Russia began in 2012 and it is expected that up to 15-20 helicopters will be assembled annually. The number of personnel engaged in the production process could exceed 100 once maximum capacity is reached. The plant is intended to meet the growing demand for the AW139 in the Russian market for civil aircraft as well as the CIS market overall.

AgustaWestland and Russian Helicopters signed the preliminary agreement to launch production of AW139 helicopters in Russia at the Farnborough International Airshow in 2008. This was followed by the joint venture agreement on 6 November 2008, at a ceremony attended by Russian Prime Minister Vladimir Putin and Italian Prime Minister Silvio Berlusconi. A shareholder agreement was subsequently signed in June 2010 paving the way to start building the plant in Tomilino.

In the summer of 2011 the final agreements on establishment of the CJSC HeliVert joint venture were signed and early during 2012 specialists from HeliVert were sent to AgustaWestland's training centre in Italy.

This medium multi-role helicopter is "superior to all other twin-engine helicopters in its class in terms of speed, flight characteristics and passenger cabin size", states HeliVert. The AW139 has maximum cruise speed of 306 km/h, maximum range in excess of 927 km, maximum flight time of five hours and outstanding performance.

The AW139 is powered by two Pratt & Whitney Canada PT6C-67C turboshaft engines, equipped with full-authority digital engine controls (FADEC) and each rated at 1,679 SHP for take-off. The maximum take-off weight is 6400 kg with an option of 6800 kg. The helicopter is configured for single pilot operations and can carry up to 15 passengers or 6-8 passengers in VIP/corporate transport configuration.

CAE

An example of the C295

New Airbus Military C295 orders

Airbus Military has received an order for six additional C295 transport aircraft from the Egyptian Air Force, bringing its C295 fleet to a total of 12 aircraft.

The Egyptian Air Force selected the C295 because of its proven versatility, robustness and efficiency for its daily transport missions combined with the ease of maintenance and low cost of operations.

This order reinforces the C295's position as the best-selling aircraft in this category, with a total of 121 C295s sold to 17 operators. Seven of them have placed repeat orders for C295 medium lift aircraft. With more than 90 aircraft in service today in 15 countries, the C295 has accumulated more than 120,000 flying hours in the most demanding conditions, from extreme cold weather to hot desert areas.

According to Antonio Rodríguez Barberán, Airbus Military Senior VP Commercial, "the C295 is exactly the kind of workhorse required for current and future airlift missions, and the most cost-efficient complement to heavy transport aircraft."

The C295's versatility also allows it to be configured in special versions such as Gunship, Ground Surveillance, Search & Rescue, Maritime Patrol, Anti-Submarine Warfare, SIGINT or Airborne Early Warning. The C295 is part of Airbus Military's family of light and medium airlifters which also includes the smaller C212 and CN235 aircraft.

Airbus Military is also responsible for the A400M programme, as well as the Multi Role Tanker Transport (MRTT) A330 and for further military derivatives based on Airbus civil aircraft. Altogether, Airbus Military has delivered more than 850 aircraft to some 140 military, civilian and governmental customers.

In more recent news, Kazakhstan has taken delivery of the first two C295 transport aircraft that it ordered last year, marking Airbus Military´s entry into the CIS regional market. The aircraft, the first two on firm contract and a further six on options to be progressively confirmed in the coming years, were formally handed over in Sevilla before the ferry flights, via Astana, to Almaty, where they will be based. They were earlier technically accepted in Seville by a combined team of Kazspetsexport, the Kazakhstan Ministry of Defence, and the Kazakhstan Air Forces. Both aircraft will be used in support of transport missions throughout the nation´s vast territory. The purchase contract additionally covers the related service support package for spare parts and ground support equipment.

MIG

The Strategic Imperative: Rafael's 'System of Systems'

SpyDer-SR

Defence of the home front, population centres as well as manoeuvring forces in the field from short to medium range missile and rocket threats is now a strategic imperative. Rafael Advanced Defense Systems of Israel has become a skilled developer and manufacturer of advanced weapon systems in the Air Defense area, offering a complete and integrated air and missile defence systems solution.

This 'system of systems' provides a complete solution ensuring defence against a broad spectrum of air and missile threats. The solution, based on a multi-layered concept, has been designed to provide optimum protection against all current and future airborne threats.

The layered concept consists of two separate double-tiered systems for defence against two different types of threats, these separate systems being modular, with maximum interoperability and connectivity.

The Iron Dome is used for missile defence against short range artillery rockets, shells and mortar with the David's Sling, produced and developed together with Raytheon, used against medium and long range rockets, short range ballistic missiles and cruise missiles. Both systems have already been selected by the Israeli Ministry of Defense as part of a comprehensive Israel air defense solution.

The Iron Dome system is already operational by the Israeli Air Force. In April 2011 the Iron Dome system successfully intercepted rockets launched towards Israel.

The other double-tiered solution offered by Rafael is the Spyder family of air defense systems. The Spyder-SR is a slant-launched SHORAD system and the Spyder-MR is a vertically launched MRAD system. The SPYDER-SR system is combat proven.

The 'Iron Dome' uses a unique interceptor with a special warhead that detonates any target in the air within seconds. The Iron Dome is effective and efficient in handling simultaneous firing (concentrated salvos) of a large number of incoming threat munitions, and is easily integrated with other radars and detection systems.

The Iron Dome system is already operational with the Israeli Air Force, and is battle-proven after it successfully intercepted over 500 rockets that were fired from the Gaza Strip at Southern Israel.

'David's Sling' provides an affordable solution against medium and long-range artillery rockets (M/LRAR), Short-Range Ballistic Missiles (SRBM) and Cruise Missiles (CM). The Detection and Tracking System is based on the phased array, search-and-track radar (MMR), and can track multiple targets. The Battle Management Command (BMC) manages detection system data processing, threat trajectory estimation, building an appropriate defense plan for the engagement, assigning weapon-to-target and launching interceptors. The launcher carries up to 12 'Stunner' interceptors in canisters and launches them from a near-vertical orientation.

The Rafael Spyder family includes two versions, Spyder-SR for short range threats and Spyder-MR for medium range threats against attack aircraft, combat helicopters, bombers, UAVs and UCAVs and stand-off weapons.

Both systems employ a unique combination of two missile types that can be used on any given mission: The Derby, active radar, beyond visual range (BVR) missile and Python-5, air-to-air dual band imaging infrared (IIR) air-to-air missile

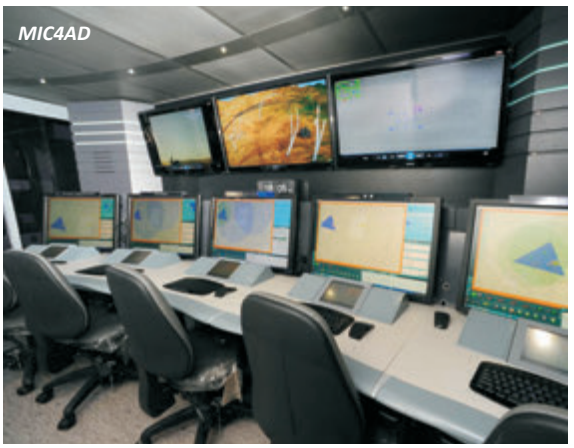
Both Spyder systems have a 360° engagement capabilityand the Python-5 and Derby missiles can be launched from full readiness state, within seconds from the time of a target being declared hostile. The systems are capable of multi-target simultaneous engagement and also single, multiple and ripple firing, by day and night in all weather conditions.

The MIC4AD: Modular, Integrated C4I Air & Missile Defense System

The MIC4AD is a Modular Integrated C4I, an advanced unified integrated C4I system that commands and controls the operation of both air and missile defense missions. MIC4AD provides "a total solution" for multi-systems, multi-layer and multi-range air and missile defense threats. Its flexible resource management engine creates an optimised solution to all threats at any level of command (national, regional or tactical), and is user-friendly and easily operated. It combines automated capabilities and advanced interactive displays.

MIC4AD operational concept takes into account several defense circles. It exploits offline resources (Data Base, Digital Terrain Model, and Intelligence) and real-time data (Radar, Identification Friend or Foe (IFF) System or other systems) all connected to the Air Traffic Control Picture and to the Mission Planning system. Together they build the National Air Situation Picture (ASP). MIC4AD powerful correlation engine correlates data from multiple sensors/platforms (radars, data link and electro-optics) and delivers real time, unified, coherent tactical picture. MIC4AD also performs threat assessment and provides hostile target classification, interception plan and effective command of the weapon system launching process.

MIC4AD optimizes resource management and allocates the most appropriate defense system, such as SPYDER, David's Sling, Iron Dome or other customer's operational air defense systems, to the type of threat. MIC4AD is a force-multiplier that offers multi-mission, multi-layer and multi-range C4I capabilities to ensure end-to-end air and missile protection.



MIC4AD

500th 'M' Model Sikorsky Black Hawk Helicopter

Troops exit a UH-60A Black Hawk

Sikorsky Aircraft Corp., has delivered the 500th H-60M Black Hawk helicopter, this to the US Army. Deliveries to date comprise 400 UH-60M utility and 100 HH-60M medevac aircraft, the latter used exclusively as an air ambulance by the U.S. Army. Also included in the 500 are 73 UH-60M aircraft sold by the Army to six foreign militaries via the U.S. Government's Foreign Military Sales programme.

Sikorsky President Mick Maurer said that "we are truly honored to build a modern combat-proven helicopter that men and women in uniform around the world can count on to perform their critical multi-role missions."

The need for an all-new 'M' Black Hawk platform emerged during the late 1990s with the requirement to upgrade the analog UH-60A and UH-60L aircraft with a integrated digital cockpit, dual digital flight controls, wide-chord rotor blades, more powerful engines and structural enhancements. The resulting 'M' model saw measurable improvements to aircraft control, survivability, lift, range, navigation and situational awareness, engine durability and maintenance costs.

Sikorsky delivered the first production UH-60M 'Mike' in December 2007, preceded by 31 low rate initial production aircraft from 2005-2007. The first production HH-60M MEDEVAC, outfitted with a dedicated clinical cabin followed in August 2008. The aircraft have accumulated a combined 200,000 flight hours to date.

The 500 H-60M aircraft are part of a planned production run of 1,375 'M' models (956 UH-60M and 419 HH-60M aircraft) the US Army plans to order through 2026. By then, the Army's total Black Hawk fleet, including upgraded UH-60A and UH-60L aircraft, is expected to reach more than 2,100 aircraft.

To meet Multi-Year 8 requirements, Sikorsky will deliver a baseline quantity of 234 UH-60M and 120 HH-60M Black Hawk aircraft for U.S. Army use and additional aircraft for Foreign Military Sales. The contract also includes 193 MH-60 Seahawk helicopters for the U.S. Navy, as well as MH-60R Seahawk aircraft for the Foreign Military Sales programme.

Sikorsky to integrate and test enhanced Black Hawk

Sikorsky Aircraft have also been awarded the Combat Tempered Platform Demonstration (CTPD) contract from the U.S. Army's Aviation Applied Technology Directorate (AATD). This programme will build upon and improve the Black Hawk platform's already high operational durability and survivability by developing and integrating a suite of advanced new technologies and establishing their benefits before transitioning them to the platform and eventual use by the Army.

A UH-60M of the Swedish Air Force

This project builds upon previous work by Sikorsky Innovations, the technology development organisation for Sikorsky Aircraft, by advancing key technologies including a zero-vibration system, adaptive flight control laws, advanced fire management, durable main rotor, full-spectrum crashworthiness, and damage tolerant airframe. The work scope of the new contract involves establishing the benefits of these technologies as a complete system through realistic ground and flight testing.

IAI's Heron : specialist in ISR missions

One of the leading Unmanned Aerial Systems (UAS) from Israel Aerospace Industries (IAI) is its Heron, unabashedly referred to as "a master in performance of ISR (Intelligence Surveillance Reconnaissance) Missions". The Heron UAS covers hundreds of square kilometers on each sortie in any terrain, be they it deserts, mountains, penetrating, dense tropical forests, scanning the coasts or deep at sea.

The Heron's sensors provide an optimal sensing for every possible scenario, with mission endurance spanning over days and nights, its electronic intelligence gear sweeps the spectrum for 'suspicious' signals, while on-board radars perform wide-area surveillance over land, sea, jungle or urban areas, while 'sharp-eyed' electro-optical payloads enable operators to positively identify and designate targets for further action.

The Heron I UAS is a robust, combat proven multi-mission and carries multiple payloads for line-of-sight missions or beyond line of sight using satellite communications. Its sensors communicate ISR data to ground stations and tactical-level operators in real-time. Various IAI Divisions provide most of these sensors, and the current Heron represents the fourth spiral development of the system, integrating the latest avionics systems, an advanced ground segment offering the ultimate level of Man Machine Interface (MMI) through its advanced, ergonomic and modular design.

For special missions, the Heron UAS can be equipped with Communications Intelligence (COMINT) radio interception gear, instantly localising radio and cellular transmissions indicating potential activity even in thick jungles. When operating over open terrain, the Synthetic Aperture Radar (SAR) from IAI's subsidiary Elta Systems provides efficient wide area coverage, automatically tracking targets. Once potential targets are located, Electro-Optical sensors developed by IAI's Tamam division can be deployed to seek their signature through gaps in the canopy.

Now, a new Foliage Penetrating Radar developed by Elta Systems, is used to locate activity and targets hidden in jungles. The airborne Satellite Communications (SATCOM) link provided by Elta Systems extends operational range of the Heron with missions upto about 1,500 km from its operating base. This also provides for increased flexibility in flight profile, particularly in mountainous terrain and long-range maritime patrols, where the UAV can descend below the datalink's line of sight, maintaining uninterrupted communications with the control center via SATCOM..

IAI`s Heron with satellite communication, electro optic, maritime radar, COMINT and ELINT payloads

The Heron 1 is equipped with an automatic takeoff and landing system (ATOL) developed by IAI, based on many years of operational experience. The system integrates two redundant reference systems, laser and Differential GPS (DGPS), to maintain maximum safety through these critical phases of the mission, in day and night, in rain and zero visibility. Since 1995 IAI has deployed the ATOL on eight different autonomous platforms, and performed thousands of missions accumulating more than 1,000,000 operational flight hours. The ATOL features are becoming imperative for integration in civil controlled airspace, where unmanned aircraft must follow strictly controlled routes without deviation, which makes the Heron as one of the world's safest UAS.Operational record

IAI Malat UAVs are operating with 49 entities in 19 countries and evaluation process of customer requirements and operational experience further contributes to IAI/Malat offering and system maturity, as demonstrated during it's over one million operational flight hours throughout the world including Afghanistan, Iraq, Kosovo, Libya, and the Middle East. Among the armed forces currently using the Heron in combat conditions, are the German and French Air Forces which have deployed the UAS's for several years in Afghanistan while the Australian and Canadian forces are leasing Herons. The Spanish and Singaporean military are also operating Searcher UAVs in Afghanistan.

The French Air Force used the Heron to support NATO operations in Libya. The Israel Air Force is operating the Heron and the latest variant Heron TP (Turbo Prop) with its operational UAS squadrons.Heron and Searcher UAS are operational with all three Indian armed forces in a variety of mission profiles and climatic conditions, including operations from Leh, one of the highest military airfields in the world. In Brazil, Herons are supporting the Federal Police forces in law enforcement and border surveillance, demonstrating the advantage of UAVs in support of homeland security missions. Heron UAVs are also operating in Ecuador and a Turkey.

Providing training and customer support is where IAI's Malat Division is well known, also offering operators full independence in operating and supporting their UAS till Depot Maintenance (D-level). The company has also established the 'UAV Academy', providing the training equipment, simulators, syllabuses and facilities for the training of operators and technical staff.

Russian Helicopters to build more Mi-17V5s for Indian Air Force

Rosoboronexport and the Indian Ministry of Defence have signed an agreement for more Mi-17V-5 helicopters to be delivered by 2015. This was formalised during the visit of Russian President Vladimir Putin to India on 24 December 2012. The new batch of Mi-17V-5 helicopters comes under the contract signed by the Indian MoD and Rosoboronexport in 2008.

Visit of the Russian President to India also witnessed signing of agreements to further strengthen military-technical cooperation between Russia and India, including for manufacture of helicopters. India has long been operator of Russian-origin helicopters and presently has a fleet of 280 in service. The Russian delegation accompanying President Putin expressed its confidence that Russia is capable of fulfilling India's needs for both civil and military helicopters.

The Mi-17V-5 helicopters for the Indian Air Force are built by Kazan Helicopters, a subsidiary of Russian Helicopters. Helicopters of the Mi-8/17 series are considered as leading examples of modern and robust rotorcraft, exemplified by the fact that they incorporate not only latest technological advances but are based on the considerable experience gained over many decades of operation worldwide. The Mi-17V-5s, have inherited the outstanding characteristics of their predecessors : superior reliability, simplicity and ease of use.

Also, during the visit of Russian President Vladimir Putin to India, Russian Helicopters, a subsidiary of Oboronprom, part of Russian Technologies State Corporation, and Elcom Systems Private Limited, signed an agreement to establish a modern industrial facility for manufacturing of Russian helicopter models, namely helicopters of the Ka- and Mi- brands in India.

This joint venture will produce major helicopter components and carry out final assembly as well as engage in ground and flight testing. It is expected that the enterprise will start with production of components for the multirole Ka-226T helicopter, and will serve as an industrial base for hi-tech Russian rotorcraft products in India.

"India is a traditional partner of Russian Helicopters in terms of helicopter deliveries. The creation of a joint Russian-Indian enterprise marks a new stage and also a logical continuation of our joint efforts in light of the growing demand for Russian helicopter models," said Dmitry Petrov, CEO of Russian Helicopters. According to Petrov, the joint venture will help drive the development of India's aerospace industry and provide for effective application of advanced Russian technologies. It will also make it possible to organize the training of Indian engineers and promote the development of highly qualified personnel across the entire production chain.

This enterprise will be eligible to implement offset projects under various procurement tenders in India where Russian rotorcraft are involved. The holding company and Elcom Systems also reached an agreement on plans to create a joint Helicopter Academy in India for the training of flight and technical personnel.

The LCA is a winner *

*But conditions apply !

Twenty years back, it was cynically referred to as the "Last Chance Aircraft" - and worse. Its designers and developers have been excoriated for endless delays. But the time has come to say it loud and clear : in the Light Combat Aircraft (LCA), India may finally have a winner. We say "may" because the "last mile" is often the most difficult one to cross. This requires first, an emphatic ownership of this step-child by its primary operator, the Indian Air Force, its chosen manufacturer, Hindustan Aeronautics Ltd (HAL) and its owner, the Ministry of Defence. Secondly it needs serious managerial boost so that the production of the aircraft—whose significant bugs have already been worked out—can be undertaken on a modern industrial scale.

But consider the payoffs ! The country gets a highly capable multi-role fighter which it can acquire in significant numbers at a reasonable cost. It also gets a potential weapons system which it can export, for commercial gain, as well as to push its military diplomacy. It would be fair to say that the LCA is the only significant weapons system created by the country's vast defence research and production base which can

compete with contemporary products like the Chinese JF-17—and win!

Though the IAF says that it is committed to bring the aircraft into squadron service, its current plans cater for just two squadrons of the aircraft, when they ought to be really talking of a score of LCA squadrons. But that is not entirely the IAF's fault, as the process of productionising the aircraft has been excruciatingly slow and the past delays have made the IAF leery of putting their eggs in the LCA basket.

Till now, ADA and HAL have built eight prototypes and six limited series aircraft which have undertaken some 1900 take-off and landing cycles without (touch wood) a single accident. Pilots swear by its ease of handling and agility. However, according to reports, the "true" initial operational clearance (IOC) of the Indian Light Combat Aircraft has been delayed yet again. The IOC, which means the aircraft can be flown by any military pilot—not just test pilots-was technically available since January 2011, but there are a range of issues that have yet to be sorted out to the Air force's satisfaction. Now, say reports, the final operational clearance will only be available by the end of 2015. This provides an invaluable opportunity to set in train steps that will ensure that the LCA emerges as the first class product that it intrinsically is.

Simultaneously, the negotiations to begin work on a Mark 2 version of the aircraft with a more powerful engine, have been completed with the prototype slated to fly by 2015 as well. And, the naval version of the aircraft which is expected to be used by the country's indigenous aircraft carrier is also in development with the prototype having flown recently.

It is important to view the LCA in comparison with the others that are flying, both as potential adversaries, as well as competitors for the export market. Various aircraft under the 10 tons of empty weight category include the American F-16, the Chinese JF-17 and the Saab Gripen. Of these the LCA is the lightest with just 5.9 tons of operational empty weight.

In part this is because of its use of carbon fibre composites (CFC). The American and the Chinese aircraft have a CFC content of near zero, while the more modern Gripen has 30 per cent content by weight. The LCA has 45 per cent, but as much as 90 per cent of its surface is made of carbon fibres. This makes it light, strong and rugged since the carbon fibre composites neither age nor corrode.

But its most important quality is that CFC does not reflect radar beams, unlike the metallic components of aircraft. In other words, this gives the LCA a naturally low radar signature or stealth

characteristics. Given its small size anyway, it is, in the words of a former fighter pilot, "virtually invisible" to adversary fighters.

The use of carbon fibre gives the LCA another advantage, it can have a low operational empty weight and compared to an aircraft with similar engines and the LCA has greater thrust to weight ratio. The LCA Mk. 2 is likely to have this as 1.53, compared to the other agile fighter, the F-16's 1.64. The Gripen's is 1.44 and the JF-17 has 1.28. Indeed, the LCA's rate of acceleration compares well with heavy two-engined fighters like the Typhoon, which has a thrust to weight ratio of 1.64.

Carbon fibre parts do not deteriorate with age nor corrode and hence the navalised version of the LCA will have a big advantage. But it is true that carbon fibre parts are expensive to make and ideally, the process should be automated and procured in large numbers to keep their prices low. India has already invested a great deal in this technology beginning with the Dhruv ALH programme in the mid-1980s and it is one of the world leaders in composites technology.

Clearly, with natural stealth characteristics, low operating costs, maneuverability and contemporary sensor and weapons suite make the LCA a real player in the global market. Indeed, according to an IAF officer, the performance of the aircraft as a fighter "exceeds that of the Mirage 2000," even when the latter is upgraded.

Though the IAF has committed itself to get two squadrons of 40 LCAs, its actual requirements are much greater. As of now the air force puts close air support or missions in support to the army in low priority. But there is great need for the IAF to take up that mission seriously, especially in the mountain areas of the north and north-east, where nearly half of the Indian Army is committed and for that, the LCA is the ideal weapon system. Further, the IAF's reliance on heavy and expensive fighters would make its reaction time to emergencies—cruise missile or UAV ingress at the country's periphery—somewhat slower because they cannot really base their expensive assets too close to the border. However, the LCA provides a quick reaction option as these would be forward based.

However, the most interesting aspect of the LCA is in relation to exports. It is clearly the one world-class product which can be used to woo friends and allies, especially in the neighbourhood. The LCA gives India the option to compete with the Chinese JF-17 in countries like Bangladesh, Myanmar, Egypt Malaysia, Indonesia, Sri Lanka, and elsewhere.

There is a wider market, too, if HAL is willing to dream big and do something about it. There is a market for some 3,000 fighters to replace the MiG-21s, F-5s, and Mirage III/5s which will retire in the coming 10 years in countries of Eastern Europe, Asia-Pacific and elsewhere. Getting even ten per cent of that market would be a stunning achievement for India.

However to achieve that goal, India needs to think BIG! HAL is still making its current limited series aircraft virtually by hand, as it were, and it has no experience in sales and marketing abroad. There will be need to transform HAL's work culture to make a product to the highest world standards. Equally important would be life time product support, again an area in which the HAL has not done too well in the past.

Still all this cannot be done by the HAL itself. The LCA programme was a national endeavour to lay the foundations for India's aerospace industry. If it is to meet that mandate–and it is on the threshold of doing that–it needs attention right now from the highest levels of government and the Ministry of Defence.

Dr. Manoj Joshi
[Courtesy Mail Today]

The C-27J offered to the Indian Air Force

The *Avro Replacement Programme* is a good opportunity for the Indian Air Force to start a process to modernise and standardise its tactical transport capability. With C-130J deliveries having commenced and with IAF crew undergoing C-17 conversion training, the IAF has upgraded its higher lift transport capability. The medium transport fleet, which is backbone of the IAF's transport force, is expected to keep pace with this renewal of the IAF's transport assets, and the Avro 748 Replacement Programme is an appropriate opportunity.

It is not a tough choice for the IAF to make. Without considering the MTA, which is an important design and development collaborative programme that will come about later in the decade, essentially it is only the Alenia Aermacchi C-27J and the Airbus Military C.295 which are realistic contenders for such a replacement programme. However, the two aircraft, often considered broadly comparable, are actually of two different categories: the C-27J particularly has a higher payload capacity, longer range and faster cruise speed. With its outstanding rate of climb, high G manoeuvrability and inherently rugged design, the C-27J has been designed to operate from any type of unprepared airstrip including sand, gravel and grass. Operating in Ladakh, at the Western desert or deployed in the north-east on Civil Protection support missions, would pose little challenge for this aircraft.

Moreover, the C-27J has so far had a sterling service life, with 98% mission availability rate and a clean safety record: 0 accidents, 0 fatalities.

Both of the two contending types have sold well in the global market, but the C-27J, which has been chosen by 10 air forces, including those of Italy, Greece, Bulgaria, Lithuania, Romania, Morocco, Mexico, and an "undisclosed African customer", can indisputably count on its service under the USAF and, its most recent customer, the Royal Australian Air Force. The Australian order for 10 aircraft in particular was made consequent to the type's positive performance reports in Afghanistan, under actual combat conditions.

Another significant advantage of the C-27J Spartan for the IAF is that it is powered by the same Rolls Royce AE2100 engines as the C-130J already in IAF service, along with similar avionics. Its loading system is also compatible with those of the C-130 and C-17 and this translates into savings in terms of economics and training as well as interoperability.

The large cross section (2.6 m high, 3.33 m wide) and high floor strength (4,900 kg/m load capability) allows heavy and large complete military equipment to be loaded. The C-27J can, for example, carry fighter and transport aircraft engines, such as

those of the C-130, Rafale and Mirage 2000, directly on their normal engine dollies without any need for specialised special equipment.

Thus, there is a pressing case to term the C-27J as an "ideal Avro replacement aircraft" for the Indian Air Force.

Finmeccanica

VAYU Interview with Dr. Peter Gutsmiedl, Head of Asia & CEO India, Cassidian

VAYU : Congratulations on your appointment as Head of Asia for Cassidian ! Please enumerate on the goals that you have set.

Gutsmiedl: Cassidian has grouped its future growth opportunities across the world into three geographical markets : Asia, Americas and Europe, Middle East & Africa (EMEA). In Asia, India has a strategic importance for us. Now that our presence here has been firmly established, we are building on our base here to strengthen Cassidian's reach in other Asian markets. Basically, we intend to use our India operations as a springboard to establish further bases across the Asian region. In my expanded role, the main goal is to develop our India operations into a regional hub and position Cassidian for long-term growth in Asia.

VAYU : You say India has a strategic standing for Cassidian. Can you elaborate?

Gutsmiedl: Cassidian regards India as much more than just an important market. We are investing in this country for a comprehensive and long term partnership. We have already embarked on local development and production in India together with our industrial partners here. The opening of the Cassidian Engineering Centre in Bengaluru is clear proof of our commitment to strengthen our partnership with India. The Cassidian Engineering Centre is the first defence oriented engineering facility owned by a foreign company in India. This also demonstrates our trust in the engineering talent that lies in this country. For Cassidian, India is strategic in the sense that we want to leverage local talent to offer customised defence and security solutions uniquely suited to the needs of our customers here. For example, in the areas of UAVs, Radar Solutions and Security Systems we are keen to tender products customised by our Indian engineers at the Center to our local customers. In addition, we see scope for marketing such solutions abroad.

VAYU : Give us an update on the Engineering Centre.

Gutsmiedl: I am proud to inform you that Indian engineers at the Centre have designed and engineered a High Accuracy Air Pressure Measurement System. It is a critical on-board sensor providing pilots with highly accurate altitude readings thus contributing to a safe operation of the aircraft in Reduced Vertical Separation Minimum fly zones. In addition, we have locally engineered a Structurally Integrated Antenna for satellite and GPS communication in aircraft. The beauty of the antenna is that this is conformal with the structure of the aircraft thus reducing drag and enhancing its stealth. We are moving swiftly towards firmly embedding Bengaluru in Cassidian's global technology network and to develop the centre here as a single source supplier of certain cutting-edge defence and security related technologies to all our global initiatives. Another recent example of our continuing efforts to establish a world-class defence-industrial footprint in India is that Cassidian India was awarded the globally recognised aerospace industry quality certification – EN/AS 9100.

VAYU : Cassidian has an impressive portfolio of UAVs. Are you offering any of these to India?

Gutsmiedl: Yes. Cassidian is strongly involved in developing the next generation of unmanned aerial systems. We have presented and successfully demonstrated the light tactical UAV Tracker to the Indian Army. This mini UAV is dedicated to surveillance and intelligence and gathers close range high resolution image with secured real-time processing in day and night conditions. The system relies on advanced image exploitation and a mission control ground segment. In production for the French Army, Tracker is easy to operate and can be deployed and hand-launched in a few minutes. Its unrivalled performance makes it a high-end solution for India's land forces' battlefield surveillance requirements.

VAYU : Did losing the MMRCA programme lead to a downgrade in India's significance for Cassidian?

Gutsmiedl: As I said earlier, India is much more than just an important market for us. It is an attractive industrial partner offering strategic opportunities to co-develop and co-produce solutions, in partnership with local players, for both the domestic as well as export markets. So your question can be answered by a clear 'No' ! For us, the strategic significance of this country goes far beyond the outcome of any single tender, even if it's the MMRCA. Cassidian has cutting-edge capabilities in the field of Airborne Solutions, Land & Joint Systems, Maritime Security & Dominance, Secure Networks, Public Safety, just to name a few. All are relevant for India's security needs. Cassidian has acquired majority shareholding in the South African Electronic Warfare specialist company Grintek Ewation and the well respected Optronics division of Germany's Carl Zeiss. This allows us to offer India highly advanced security electronics and sensor solutions. So, as you can note, we have much to offer to India. We are here for the long-term.

VAYU : Please give us a preview of what Cassidian is showcasing at Aero India 2013.

Gutsmiedl: We will be giving visitors at the Show a small preview of the great work that our Indian engineers are doing at the Cassidian Engineering Centre here in Bengaluru. The High Accuracy Air Pressure Management System as well as the Structurally Integrated Antenna, both, designed and engineered locally, will be on display. Besides, we will be showcasing the Missile Approach Warning System (MILDS), which we co-developed with DRDO's Defence Avionics & Research Establishment (DARE). On the UAV front, we are bringing our man-portable, fixed wing, mini UAV Tracker, the Medium Altitude Long Endurance (MALE), UAV Harfang and tactical Vertical Takeoff & Landing (VTOL) UAV Tanan. To view the full range of exciting capabilities we are bringing, I invite you to visit us at the EADS pavilion, outside Hall C, OD-6 at Aero India 2013.

HAL

VAYU Interview with Ellen Lord, President and Chief Executive Officer, Textron Systems

VAYU : What are the key technologies and products that are being showcased by Textron Systems at Aero India 2013?

EL : Aero India attendees will learn more about several Textron Systems products this year. Our new Shadow® M2 Tactical Unmanned Aircraft System is the next generation of our renowned Shadow 200 Tactical Unmanned Aircraft System. The Shadow M2 builds on the overwhelming success of the Shadow 200 with greater performance and multi-mission flexibility. We will showcase our Aerosonde® Small Unmanned Aircraft System at the show as well. It delivers efficient, expeditionary shipboard and land-based operations along with long endurance.

Our Tactical Sensor Intelligence Sharing, or Tac-SIS™, system allows users to seamlessly integrate live, full-motion video into the aircraft cockpit and ground control stations, enabling pilots and operators to view and relay real-time data. The Tac-SIS™ system is the cornerstone of Textron Systems' manned/unmanned teaming technology. We see many possible applications in India. The Tac-SIS system is available in partially integrated mobile unit or fully integrated cockpit configurations.

The Sensor Fuzed Weapon (SFW) is an air-delivered area weapon that provides a highly effective and reliable anti-vehicle weapon to the Indian Air Force. Based on extensive testing and use in combat by the U.S. Air Force, SFW is proven to leave less than one half percent unexploded ordnance, or UXO. SFW is one of the world's most effective weapons, without putting ground forces or civilians at risk after its use.

Another weapon we will display is Spider, a man-in-the-loop, networked munition system that incorporates sensors, communications and munitions for small unit force protection. The Spider system is capable of controlling both lethal and nonlethal effects, and is designed to prevent harm to non-combatants while safeguarding warfighters.

We also will showcase our family of Unattended Ground Sensors (UGS). These ground sensors are a scalable, effective solution for both tactical and non-military applications covering a variety of terrains and targets. This includes the MicroObserver® UGS system, which is a next-generation unattended ground sensor solution that provides situational awareness for perimeter defence, force protection and border security.

Vayu : What are your overall expectations from the Aero India 2013 and the coming years for the Indian market?

EL : Aero India 2013 arrives during an exciting time for Textron Systems, as we are uniquely positioned to support the Indian government and its armed forces. We not only offer a multitude of battlefield-proven platforms for land, sea and air, but also robust software solutions and after-market services. With that broad base of knowledge, we are speaking with many organisations to determine how we can meet India's current and emerging requirements.

Vayu : Can you review the current Indian RFPs in which Textron Systems is participating in and what is the status?

EL : We continue to discuss our product offering with government, armed forces and security agency customers, and we have responded to several requests for information. The government sets the priorities for acquisition activities in key areas, and Textron Systems is responding as requirements are established and funded.

Vayu : How can Aerosonde enhance the capabilities of the armed and paramilitary forces?

EL : As mentioned earlier, the Aerosonde Small Unmanned Aircraft System is ideally suited for both land-based and shipboard operations in spaced-constrained environments. In fact, the Aerosonde can be deployed in its shipboard configuration with no

ship alterations, an affordable and space-saving solution for our customers. The Aerosonde aircraft's single electro-optic/infrared payload delivers day-and-night, persistent intelligence, surveillance and reconnaissance, while its large payload size, weight and power can accommodate another payload of choice for multi-mission flexibility. It utilizes AAI's one-piece Launch and Recovery Trailer and the Expeditionary Ground Control Station for expeditionary land- and sea-based operations.

Vayu : Last year the BSF found tunnel running between India and Pakistan at the international border. After this BSF issued QRs for 'Unattended Ground Sensors', Has Textron Systems responded to it, and how can your UGS enhance the capabilities of BSF in handling such situations?

EL : Textron Defense Systems has communicated its interest in providing Unattended Ground Sensors (UGS) to India for use by BSF and paramilitary forces. Our MicroObserver® UGS system has been deployed to tactical forces in the United States and foreign armies, is mature, has a long field life measured in years, is very capable at detecting and classifying different types of threats, and is easy to use, requiring almost no training.

TDS_SFW.

Vayu : How are Textron Systems planning to increase its presence in the growing Homeland Security market in India?

EL : Textron Systems is supporting homeland security needs for the Indian Ministry of Home Affairs (MHA) at the departmental level and within key agencies that fall under the MHA. Our India-based operations are supported through Textron India Private Ltd., which works closely on engineering and other business solutions for Cessna, Bell Helicopter and Textron Systems. Working actively and in tandem with key Indian business partners, our goal is to support the needs of all security-related agencies through adaptation and implementation both American and Indian knowledge and expertise. We fashion solutions and products tailored to fit the differing needs and budgets for the security sector. Recognizing that India has pre-existing capabilities, we provide options via an integrated systems approach wherein we either integrate and augment existing capabilities with more advanced systems or develop new products that fill gaps and requirements that are not fully served by pre-existing systems.

Vayu : Are Textron Systems planning to partner with Indian private sector companies?

EL : We are actively discussing potential joint ventures with many companies, and see the potential for great mutual benefit in such partnerships.

VAYU Interview with Michael Christie, Senior Vice President, India, BAE Systems

VAYU : How would you describe your experience of working on the Hawk programme and with India in particular?

MC : Fantastic ! I have been lucky enough to visit India on many occasions and its a country that I have a great affinity with. I am also very proud of the relationships we have established in India, with the Indian Government,Hindustan Aeronautics Limited and the Indian Air Force.

VAYU : What is BAE Systems showcasing at Aero India ?

MC : This is a real highlight in the aerospace calendar. The event provides unique opportunity to meet with customers, the industry, colleagues and our many friends in India. The Hawk and our training capabilities will feature strongly and we will be showcasing a 3D virtual cockpit representation of the Hawk T Mk.II, which recently entered service with the UK's Royal Air Force. We will also be highlighting some of BAE Systems' unmanned combat air systems technologies and also our digital network capabilities.

VAYU: Why do you think Hawk is so successful?

MC : From an aerodynamic point of view Hawk has always been a fantastic aircraft – its easy to fly and an extremely stable platform to build upon. The latest versions of Hawk make it, in effect, a completely new aircraft but the huge advantage that the Hawk Advanced Jet Trainer has over the competition is that it was not designed as a brand new project. Hawk has been developed over the past 20 years. Its been a constant evolution based on customer experience and feedback; and emerging customer requirements.

VAYU : What is so different about the latest Hawk?

MC : Today's Hawk trains pilots to fight and it uses the same type of digital glass cockpit as one would find on the latest combat aircraft, with Multi-Function Displays, Head-Up Display and Hands-on-throttle-and-stick. Its a million miles away from the cockpit you would have found in older versions of Hawk !

Then there's the really clever part : Hawk's embedded simulation and emulation technologies are better than anything the competition can offer. For a trainee fighter pilot, this makes a real difference because it allows one to turn the sky into a virtual, front-line warzone. Advanced data-link technology creates synthetic and simulated threats such as hostile radar, aircraft and weapons. All this information is displayed in the cockpit on displays that replicate what one would see in a fourth or fifth generation fighter aircraft. So, Hawk brings front-line systems into the fast-jet training environment and it does it in an extremely cost-effective way. That's why it is and will continue to be successful.

VAYU : India is already one of the largest customers for Hawk. When do you expect to receive the order for the third batch of aircraft?

MC : We received a Request For Proposal from Hindustan Aeronautics Limited in 2012 for the potential purchase of a further 20 Hawk aircraft. We have provided an initial response to the RFP and will be providing a full response by the end of February. We will then wait for things to follow their natural course of progression through the approvals route.

VAYU : How many Hawks have been sold?

The recent order from the Sultanate of Oman took the total number of Hawks sold to 998. India has been a fantastic customer for Hawk and I would personally be very pleased if it is the further order for India Hawks that takes the number of aircraft sold past the milestone 1000 mark.

VAYU : What progress has been made to establish a long-term, product support solution for India's Hawk aircraft?

MC : There are a number of matters progressing to ensure the availability of the aircraft including the establishment of a long-term product support agreement. We are actively working with HAL and the Indian Air Force to make this happen.

I think everyone wants to see a solution that will ensure that the Hawk aircraft are available whenever they are required. I should point out that the Hawk Advanced Jet Trainer is performing well in the service of the Indian Air Force and is delivering excellent training to future front-line pilots.

VAYU : What does the future hold for Hawk?

MC : Today's front-line fighters are becoming ever more advanced, with improved capabilities, more efficient radars, weapons and sensors. For Hawk, a big selling point is that we can replicate all of this through the continuing development of Hawk's simulation and emulation capabilities. This is an extremely cost-effective way of working and it means that Hawk is well positioned to meet the demands of air forces around the world no matter what frontline aircraft they operate, both now and in the future.

The Boeing P-8I: An Eye in the Sky for the Indian Navy

Keeping to the exact schedule, Boeing completed on-site delivery of the first P-8I aircraft to the Indian Navy within 48 months of contract signing. This was on 19 December at Seattle. The remaining seven aircraft will be delivered to the Indian Navy by end 2015.

A military derivative of the Boeing Next-Generation 737-800, the P-8I is arguably the most advanced anti-submarine and anti-surface warfare aircraft in the world and will advance the Indian Navy's missions for maritime reconnaissance of the vast 7,500-kilometer coastline. Since contract signing in January 2009, Boeing teams have worked hard to meet the programme milestones and prepare the aircraft for delivery.

The first P-8I carried out its maiden flight on 28 September, 2011, taking off from Renton Field near Seattle. The second aircraft completed its first flight on 12 July, 2012, and the third made its first flight on 29 November, 2012. Missions systems installation and checkout work continues on the second and third aircraft, and final assembly of the fourth and fifth P-8I aircraft is underway.

Boeing initiated the programme's official flight test in July 2012, and this is now nearly complete. Boeing test pilots have put the P-8I through its paces over a US Navy test range west of Neah Bay, Washington.

Boeing teams initially tested the P-8I's mission system, which includes its sensors and communication systems. They then transitioned to "stores" tests, during which the P-8I carried inert weapon shapes underwing to prove the aircraft's capability of carrying all the weapons the Indian Navy will use during regular missions. The stores the P-8I carries are identical in shape and size of actual weapons, including the Harpoon anti-ship missile, depth bombs and torpedoes.

The P-8I combines superior performance and reliability with an advanced mission system that ensures maximum interoperability in the future battlespace. The aircraft is equipped with advanced sensors and weapon control technologies and is capable of broad-area, maritime and littoral operations. The P-8I carries anti-submarine weapons including the Harpoon anti-ship missile, torpedoes and depth bombs. The aircraft's enhanced internal fuel tanks enables it to fly 1,100 kilometers to a patrol area, remain on station for up to six hours and then fly back to base, with reserves.

The Boeing-led industry team involved in the development and delivery of the P-8I aircraft includes CFM International, Northrop Grumman, Raytheon, Spirit AeroSystems, BAE Systems and GE Aviation.

The P-8I also features a host of indigenous systems made by Indian suppliers such as Hindustan Aeronautics Limited (HAL), Bharat Electronics Limited (BEL), Electronics Corporation of India Limited (ECIL), Dynamatics Technologies, Tata Advanced Materials Limited (TAML) and Avantel. These companies provide the aircraft with technologies and parts for the weapon bay doors, tail cones, Identification Friend or Foe Transponder, Identification Friend or Foe Interrogator, Auxiliary Power Unit (APU) door fairings, mobile satellite systems, power and mission equipment cabinets, data link communications and speech secrecy systems.

The Indian Navy, first international customer for the P-8 maritime reconnaissance and ASW aircraft is to reequip its Squadron 312 'Albatross' with the type.

VAYU Interview with Cmde Sujeet Samaddar Director & CEO ShinMaywa Industries India Pvt Ltd

VAYU: ShinMaywa Industries India Private Limited have now been involved with the Indian aerospace sector for past one year. How has the journey been so far?

SS : I think we have no reason to complain. Things are moving at a pace which is satisfactory. We have been in India for just more than a year and in this time, we have made considerable progress. We have also had some serious discussions with some potential Indian industrial partners. So, while there is progress at the same time, we definitely want to come into India in a very careful and calibrated manner, since our interest is certainly long term.

VAYU: What are the drivers that make you believe that acquiring an amphibian aircraft capability is important for India?

SS : Development of such capability and induction of the appropriate enabling systems signal not only a firm commitment towards maintaining regional stability and maritime security and safety but also is an affirmation of meeting national responsibilities that come with great power status. Whilst ships, submarines and conventional aircraft are all able to, some way or the other in fulfilling various missions, these platforms are limited in some manner or the other. Modern amphibious aircraft make possible a range of options not achievable by any single platform. Its unique multi-modal design permits airborne, seaborne and land operations in unified manner. For India, aspiring to regional power status, its Navy must not only be able to address the immediate security requirements of the country and prevail against enemies of the state, but also must be able to contribute towards benign and constabulary operations in its area of interest and influence for the regional good. From a maritime perspective, such power status means protection of global merchandise in the international oceans to ensure freedom of navigation and safety at sea then promote regional stability through an open and participative security architecture and importantly, alleviate suffering during disasters in the littorals of friendly nations and, above all have the constabulary capacity to maintain order at sea. The US-2i amphibian aircraft is maritime power personified.

VAYU: It is known that the US 2i amphibian aircraft is also an effective SAR platform. What are the other operational roles where this aircraft can be employed effectively?

SS : Amphibious aircraft combine capabilities for rapid surveillance and immediate response in a single platform, whether for relief or apprehension. The modern amphibious aircraft is a veritable force multiplier since it fulfils a multitude of missions. Unlike helicopters and land-based aircraft, amphibious aircraft can land at the area of action, and enforce both the

will and the law of the country. Unlike ships, amphibious aircraft can reach the target area rapidly and thus prevent destruction or dumping of contraband. Amphibious aircraft can be tasked for multifarious naval missions, in addition to the traditional SAR role in multifarious manner including Surveillance, reconnaissance, intelligence gathering and on-spot investigation in the EEZ and on the oceans including search and seizure as also 'hot pursuit'. In addition, these can provide long range naval logistic and maintenance support with ferrying of specialised dockyard personnel and spares to a Fleet at sea. Also, amphibious aircraft can complement long range maritime patrol aircraft for SAR and deployment of strategic air assets out at the high seas.

VAYU: What is the strategy that ShinMaywa is likely to adopt to cater for the offset obligations?

SS : We have a very interesting offset strategy. When we finally are ready, we will share with you. It is about genuinely building capacity in this country. We look at offsets as not obligations but as an opportunity, to build a good business in India, .a really high technology aerospace cluster which can help supplement the efforts of HAL. We should be able to augment the national capability in aircraft manufacturing, in the private sector. This is our plan and we are working hard to realise it.

VAYU: What are ShinMaywa's long-term plans for India, both in the civil and defence sectors, in view that India is seeking to transform from being 'a buyer' to becoming an equal development and manufacturing partner ?

SS : Our present focus is to introduce the US-2i for the Indian Navy. In addition, we have regular interaction on our other engineering products and environmental systems. The long term aim is not to just establish a standard 'buyer-seller' relationship by offering 'state-of-the-art products' but also to build up service and maintenance facilities of some of our products in India, involve Indian MSMEs in our supply chain, work with Indian design and engineering companies for new products and perhaps also engage with India academia . This all would help in bringing new technology into the country. However, we wish to expand our operations in calibrated manner which best suits the Indian business environment and contributes to needs of the Indian Armed Forces as well as other potential customers in India.

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SELF AD -39

Aiming Beyond the BMD

Subject to clearance of the Cabinet Committee on Security (CCS), India's Ballistic Missile Defence (BMD) system is reportedly "ready to be in place at short notice." Technologically this may denote India's growing military technology prowess, but strategically this is likely to generate more questions than answers. For instance, will it destabilise the regional nuclear balance in vogue? What is the military objective of India's BMD – will it help effective implementation of the Cold Start Doctrine? Or, will it beget a regional arms race? Will it address all missile contingencies that India is likely to confront?

While BMD advocates validate India's move as an imperative to ensure survivability of its nuclear assets for a second-strike capability, they overlook the fact that ballistic missile threat is not the only form of missile contingency India is confronting today. A cursory look at the missile inventory and capability of neighbouring countries would suggest that both China and Pakistan have prioritised cruise missile development in their defence modernisation programmes.

According to Taiwan Defence Ministry sources, "over 100 cruise missiles are presently deployed" by China. During 2004-2009, Beijing has tested various cruise missiles some 30 times, including the second-generation DH-10 (LACM) series. According to *Bulletin of Atomic Scientists* (2011), the DH-10 which has a range of more than 1500 km, numbers somewhere between 200 and 500 with some 40 and 55 launchers. This has further developed into the CJ-10 cruise missile family.

Pakistan, on the other hand, fears that India, by deploying BMD, may neutralise its current ballistic missile-based nuclear deterrent. Islamabad's strategy now is to strengthen its cruise missile inventory. The nuclear-capable *Babur* (*Hatf-7*) is based on the BGM-109 Tomahawk and has been test-launched eight times by June 2012. The turbojet-powered *Ra'ad* (*Hatf-8*) is nuclear capable and has been test-launched for the fourth time.

Bangladesh is also reportedly taking interest in missiles and has commenced some interaction with China in regard to missile technology development. On 11 May 2008, the Bangladesh Navy successfully test-fired the C-802 missile in the Bay of Bengal, following an upgrade to the missile system with the assistance of China. Dhaka is also acquiring the European Otomat Mk-II SAM that are proclaimed as "defensive" in nature and function. Still, their range of less

than 200 km makes them a defence only against India. Anybody's guess which way the Bangladeshi missile programme would proceed a few decades down the line. Strategists view the missile programme that Bangladesh has begun with Chinese help is part of Beijing's considered strategy to encircle India.

Ballistic missile threats from the neighbourhood do indeed remain a great concern for India, but do they have any credible defence against the sophisticated cruise missiles pilling up in its vicinity? Suffice it to say that even for the United States, intercepting lower-altitude, slower-flying cruise missiles remains a pressing challenge. During 2003 *Operation Iraqi Freedom*, Patriot missiles successfully intercepted all nine ballistic missiles fired by the Iraqi forces but they failed to detect any of the five 'primitive' cruise missiles Iraq employed.

Starting from *Operation Crossbow* (1944) till *Operation Iraqi Freedom* (2003), the use of cruise missiles in the world has exceeded that of ballistic missiles by over 3 to 1 (19,465 against 5875). Currently around 130 types of cruise missiles are deployed by 75 countries. In Asia, around 11 countries have active cruise missile programmes. The evolution trend of cruise missile technology shows that they are becoming more 'intelligent' and lethal owing to the sophisticated enabling technologies like GPS, TERCOM, composite materials, computers, and satellites. They are more cost-effective than fixed-wing fighters or bombers; therefore, both horizontal and vertical proliferation of cruise missiles can be expected as they can be equally lucrative for terrorists in their nefarious designs.

However, a coherent conception of the threat of cruise missile proliferation and credible defence against them is still unavailable and India must view the cruise missile programmes of its neighbours with alacrity. By exploiting India's long coastline, terrorists can even hide cruise missiles in commercial cargo, stay close to India's territorial waters, and then launch cruise missiles. In recent years, increasing numbers of commercial container ships are entering Indian ports, but only the Jawaharlal Nehru Port in Mumbai is Container Security Initiative (CSI) compliant.

Thus, India while preparing for BMD, should strategise for defence beyond the ballistic missile threat. A national debate over the imminent cruise missile threat and existing capabilities to defend against them is imperative. The pros and cons of India joining the Missile Control Regime (MTCR) may be considered. Staying outside the regime, India's voice against the Sino-Pak clandestine nuclear-missile nexus will not attract much attention. In the long-run, an active cruise missile defence (CMD) in line with the US two-layer CMD model may be considered. This would certainly put enormous burden on the national exchequer, but does India have the luxury to overlook this or any alternative to meet the emerging threat?

Dr. Sitakanta Mishra
Research Fellow, CAPS

IAI MBT

Swedish Parliament clears Gripen E/F

On 12 December 2012, the *Riksdagen* (Swedish Parliament) voted strongly in favour of Saab's next-generation JAS 39 E/F Gripen combat aircraft. 264 members of parliament voted in favour with only 19 against the procurement of 40-60 new generation Gripen fighters.

According to Eddy de la Motte, Head of Gripen Export at Saab, "It is a historic day for the Gripen, with unequivocal home political support securing the next generation fighter, Gripen is now even better placed on the export market. We see an immense interest for Gripen more than ever before from countries around the world owing to its unrivalled price/performance capability. At the same time defence budgets are ever more squeezed due to the current economic climate." The total cost of the Swedish acquisition, including maintenance and operation is estimated at SEK 90 billion (approximately $13.5b) up until 2042.

Meanwhile, defence analysts have opined that the Gripen NG could well be considered as an alternative to the F-35A for the Canadians, owing to ever spiraling costs of the Joint Strike Fighter.

J-15 trials on Chinese carrier 'Liaoning'

On 25 November 2012, China announced successful flight trials from its first aircraft carrier, *Liaoning*, employing a number of their new J-15 shipborne fighters for the trials. These were key tests since the carrier was commissioned on 25 September 2012. "The carrier and equipment have met all requirements achieving good compatibility," according to the PLA navy spokesman.

"The People's Liberation Army Navy PLAN is now capable of deploying fighter jets on the carrier", Vice Admiral Zhang Yongyi stated. Five J-15s had taken part in the trials, the aircraft based on the Russian Sukhoi Su-33, which "was capable of carrying multi-type anti-ship, air-to-air and air-to-ground missiles".

Sadly, the day following the achievement, the senior engineer, Luo Yang, who led the programme, passed away

after a cardiac arrest, while participating in flight landing trials. Mr. Luo had played a key role in production of the J-15, and was also involved in tests on board the *Liaoning* in recent weeks.

Oman to acquire Typhoon and Hawk

The Sultanate of Oman has contracted to purchase 12 Typhoon and eight Hawk Advanced Jet Trainer (AJT) aircraft from BAE Systems. As well as supplying aircraft, BAE Systems will provide in-service support to the Royal Air Force of Oman's (RAFO) operational tasks. Deliveries are expected to commence in 2017. Oman becomes the seventh country in the world, and the second in the Middle East, to operate the Typhoon, joining the air forces of the United Kingdom, Germany, Italy, Spain, Austria and Saudi Arabia.

Guy Griffiths, Group Managing Director for BAE Systems' International business said, "Receiving this contract is excellent news for both BAE Systems and the Eurofighter Typhoon consortium. BAE Systems has a long history of working in Oman and we are delighted this contract will enable us to continue to work together. We believe that Oman has now added the most advanced fighter jet and proven training aircraft available in the world to its military portfolio. We look forward to working in partnership with Oman's Ministry of Defence, and the Royal Air Force of Oman, to ensure this is a highly successful programme that maximises the potential of both Hawk and Typhoon."

This order of Hawk AJT's follows an order from the Kingdom of Saudi Arabia in May 2012 , which takes the total number of Hawk aircraft sold, or on order, to 998.

This decision also strengthens the long standing relationship between BAE Systems and the Sultanate of Oman, which currently also operates Jaguar strike fighters and trains pilots on an earlier variant of the BAE Systems Hawk.

Potential Rafale offer to Canada

"Dassault Aviation will respond to an information demand from Canada on its Rafale fighter and would be ready to participate in a tender, were the Canadian government to backtrack on its support of Lockheed Martin's F-35", stated the Company's new chief executive Eric Trappier.

"Canada is potentially the first country that could challenge the F-35….we are ready to explain what a Rafale offer could be, its operational capabilities and an industrial cooperation," he added in an interview. According to Canadian officials, the government would restart the process of searching for a new fighter for the Royal Canadian Air Force following continuous escalation in F-35 programme costs.

Elbit to upgrade Israeli C-130Hs

Elbit Systems Aerospace Division has been awarded a contract by the Israel Ministry of Defence to upgrade the Israeli Air Force's C-130H Hercules transport aircraft, which will "extend the operational life of the aircraft and significantly improve its operational capability, particularly in precision flying, low-level night flight and operations in adverse weather. The modernisation will contribute to improved flight safety and reduce operating costs, by introducing cutting-edge digital systems to replace obsolete analog systems that have become unreliable and costly to maintain after four decades of intensive service with the Israeli Air Force".

SLAF to order JF-17s

According to Sri Lankan sources, the Sri Lanka Air Force (SLAF) may be the first 'foreign' air arm to procure the Sino-Pakistani JF-17 light fighter, with six aircraft initially involved. The Ministry of Defence and Urban Development have listed these aircraft to be purchased under the 2013 finalised projects.

JF-17s of the Pakistan Air Force, the first air arm to induct the new light fighter

In addition, 17 Kazan Mi-17 medium utility helicopters and 2 Bell 206 light helicopters are also to be procured under the same project heading.

AS332 L1 Super Puma helicopters for Finnish Border Guard

The Finnish Border Guard is to expand its Eurocopter fleet with the acquisition of two additional AS332L1 Super Puma helicopters, fully equipped for maritime search and rescue missions in the country's challenging conditions. With deliveries scheduled for 2015, the rotorcraft will be configured as the AS332 L1e version, incorporating integrated advanced cockpit and automatic flight control systems used on Eurocopter's EC225 helicopter. They are to be based at Helsinki and outfitted for day/night operations and equipped with high-definition forward-looking infrared (FLIR) technology, a four-axis autopilot and full deicing.

The Finnish Border Guard already operates three AS332L1 rotorcraft, which are assigned to its Turku base on the southwest coast of Finland. The service has nearly 25 years experience

with these Super Pumas validating the service's reputation for professionalism and effectiveness, while also confirming the helicopter's capabilities in the most extreme environment.

Northrop Grumman INS for Typhoon Tranche 3

Northrop Grumman has been selected by the Eurofighter Consortium and prime contractor Alenia Aermacchi to provide inertial and satellite navigation systems for Tranche 3

Eurofighter Typhoon multirole combat aircraft. Northrop Grumman Italia will provide the Eurofighter Fibre-optical Gyro Inertial Navigation System and a global positioning system (GPS) receiver for the Eurofighter aircraft in all of the programme's participating nations, including the United Kingdom, Germany, Italy and Spain. The new contract is valued at 30 million euros and builds on Northrop Grumman's extensive experience with the Eurofighter programme spanning more than 20 years as a supplier for all three tranches of the programme. Northrop Grumman Italia has delivered a total of more than 400 inertial navigation systems for Tranches 1 and 2 of the Eurofighter.

PLA Air Force exercises in Lanzhou Military Command

The People's Liberation Army (PLA) northwestern Lanzhou Military Command, whose charge includes the Aksai Chin region of north eastern Ladakh, carried out a large-scale, 12-day military exercise involving more than a dozen air force units on 7 December 2012. Held in the Gobi desert close to the border with Mongolia, near the base of the Lanzhou Military Command, the exercise involved 14 air force units and at least 100 pilots flying Jian-10 and Jian-11 fighters.

The exercise was described as the biggest "air-to-air strike assessment" drills conducted by the PLA Air Force (PLAAF) in recent years, involving "simulated air combat" to measure the fighting capability in modern warfare scenarios. It was also the first major exercise following Xi Jinping assuming charge both as General Secretary of the Communist Party of China (CPC) and Chairman of the Central Military Commission (CMC) in November 2012. Mr. Xi will take over as the President when Hu Jintao steps down in March 2013.

Yang Yongfei, an air force brigade commander, was quoted as saying that the drill was "a response to political tasks set out at the Communist Party's National Congress and reflected the army's achievements in information warfare modernisation".

Patriot, SM-2 test engages ballistic and cruise missile targets

Raytheon's radars, missiles and integrated systems played key roles in the US Missile Defence Agency's Flight Test Integrated-01, the largest combined developmental and operational integrated live fire missile defence exercise conducted.

During the test, Raytheon's AN/TPY-2 X-band radar detected a medium range ballistic missile target and provided cues to the THAAD weapon, enabling successful intercept. Raytheon's Patriot system detected, tracked and successfully intercepted a short range ballistic missile target with a PAC-3 interceptor and a low-flying cruise missile target over water. The company's Standard Missile-2 was fired from the USS *Fitzgerald* and engaged a low-flying cruise missile.

Next-Generation Air Defence Radar

The US Air Force has contracted Northrop Grumman to demonstrate technologies for its Three-Dimensional Expeditionary Long-Range Radar (3DELRR) programme. Designed to replace the current AN/TPS-75 radar systems, 3DELRR will be the primary Air Force ground-based, long-range radar for detecting airborne threats. The pre-engineering and manufacturing development contract, valued at $34.7 million, will last 15 months. Based on Northrop Grumman's active electronically scanned array (AESA) radar technology, the company's 3DELRR solution is a highly mobile, affordable and reliable radar system.

Dornier 228 Next Generation sales

The RUAG Dornier 228 Next Generation aircraft which was on display at ILA 2012, has two new customers including an 'unnamed' Asian customer, due to be delivered in the second half of 2013. On 31 August 2012, an aircraft was delivered to the German Navy, which took over from the earlier Dornier 228-201 and will conduct environmental surveillance activities in the North Sea and the Baltic.

China's Y-20 Heavy Lift Transporter

Early in the new year, Chinese officials formally confirmed existence of the Xian Y-20 heavy lift transport aircraft, following the emergence of grainy photos on various websites of an indigenous Chinese heavy lift transport aircraft undergoing taxi tests at an unknown location in 2012. The type has been known to be in development since 2005, with scale models revealed in 2009.

The aircraft photographed in December 2012 appears to be sized between the Airbus A400M and the Boeing C-17 Globemaster III and closely resembles the latter in overall layout. Considering that Dongfan Chung, a former Boeing engineer was convicted in July 2009 of selling secrets related to the C-17 to China, the similarity is "hardly surprising".

The engines on the prototype appear to be low-bypass turbofans, which means China will probably use Soloviev D-30 or WS-18 engines. As evidenced by the J-20 and J-31 projects, engine technology appears to be the largest obstacle to the growth of Chinese aviation industry, with the Y-20 being the third in-development Chinese aircraft lacking suitable modern powerplants.

Artist's depiction of the Y-20

China's recent military expansion necessitates large transport aircraft and the PLAAF already operates 20 Russian Il-76 aircraft with a further 30 on order. There is also a requirement for heavy airlifters to respond to domestic emergencies, such as during the 2008 Sichuan Earthquake.

China's Defence Ministry has stated that they are developing "a large transport aircraft" to build a capable air transport framework and that "the advanced long-range carrier is being developed to serve the military modernisation drive." The ministry gave no indication as to when the aircraft would be deployed, only that the programme is "going forward as planned."

Brazil puts F-X2 programme "on hold"

In another setback to the long-delayed F-X2 fighter programme, Brazilian president Dilma Rousseff has announced that the acquisition of 36 new combat aircraft will be "deferred until the Brazilian economy recovers".

Gripen NG

With three aircraft types– the Boeing F/A-18E/F Super Hornet, Dassault Rafale and Saab Gripen NG – already shortlisted, Brazil's government was expected to sign a contract during 2012, but the award has now been indefinitely postponed funds with instead channelled toward tax cuts and infrastructure spending.

Rafale F.3

The F-X2 deal was earlier expected to be signed in 2009, amid a period of prosperity in the Brazilian economy, but the contract award was delayed, and then put on hold for a year after Rousseff's election in November 2010.

Boeing F/A-18 Super Hornet

Sikorsky potential contractor for USAF

After examining several options, Sikorsky now appears to be the sole potential contractor to meet the US Air Force's combat rescue helicopter (CRH) requirement. The company will possibly offer a modified variant of the MH-60 Black Hawk special operations aircraft as it is already building Black Hawks to expand an existing fleet of HH-60G Pave Hawks, a type that will be replaced by the CRH.

Earlier, the USAF had considered placing a sole-source contract with Sikorsky, before broadening the tender contendors. Many bidders have dropped out because of the evaluation criteria, which makes this "essentially a price shootout". Northrop Grumman, which had partnered with Europe's AgustaWestland, planned to offer a modified version of the latter's AW101 for the requirement, but later backed out from bidding.

Boeing, which had won the original combat search and rescue (CSAR-X) contract in 2006 with its CH-47 Chinook, is also dropping out, stating "while both the Boeing H-47 Chinook and the Bell Boeing V-22 Osprey have well-documented successes conducting search and rescue missions, neither aircraft is competitive for this programme as is currently structured." Bell Helicopter and EADS North America have also ruled themselves out of the contest.

More Super Hornets for RAAF

Consequent to delays on the F-35A programme, the Government of Australia has sent a letter of request (LOR) to the US Defence Security Cooperation Agency seeking information on costs and availability for a possible purchase of 24 additional Boeing F/A-18F Super Hornets.

The LOR is latest step in a process aimed to assess the nation's air combat capability options in the light of delays to the Lockheed Martin F-35A Joint Strike Fighter and retirement of the Royal Australian Air Force's 71 F/A-18A/B Hornets. In May 2012, the Australian Government announced that they were delaying acquisition of an initial 12 F-35As until 2014-15 to reduce costs, and that it would launch a transition plan to assess options to ensure that a gap does not emerge in the RAAF's air combat capability.

Australia received 24 Super Hornets between March 2010 and October 2011, acquired to cover the gap between the retirement of the General Dynamics F-111 fleet and introduction of the F-35A.

C130Js for Iraqi Air Force

On 12 December 2012, the Iraqi Air Force received a third C-130J aircraft at a rollout ceremony held at Lockheed Martin's factory. Under a programme, 18 pilots, 18 loadmasters, and some 50 maintainers of the Iraqi Air Force are being trained for operations with C-130Js. The C-130J purchase agreement with the IqAF provides a total of six C-130J aircraft, support equipment and training. Three were delivered by 12 December 2012 and three more will be delivered in 2013.

Britain delays flight-training contract

The British Ministry of Defence is to place a contract for balance of its Military Flying Training System (MFTS) programme during 2015, with industry partner Ascent Flight Training having issued a request for proposals for the requirement, which covers fixed-wing rear crew training for the Royal Air Force, Royal Navy and Army Air Corps. The MoD's partner for the MFTS programme adds that it "will manage the procurement process to contract a holistic training service, including the new aircraft in 2015."

Potential bidders have been given upto 90 days to respond to the document, with Ascent seeking "an output-based specification that includes supplying aircraft, aircraft-related infrastructure and support to 2030 and beyond."

According to Ascent managing director Jim Keeler, "We are seeking to increase the use of synthetic training technology while continuing to train key tasks via live flying to ensure best for money." A 50:50 joint venture between Lockheed Martin and Babcock International, Ascent has already overseen the introduction of 28 BAE Systems Hawk T2 advanced jet trainers operated by the RAF's No. 4 Squadron at Valley in Anglesey.

First Su-30SM fighters for Russia

The Russian Air Force has received the first two Sukhoi Su-30SM multi-role fighters, these being delivered from Irkutsk to the test and evaluation centre at Akhtunbish late November 2012. A production order was signed in March 2012 to acquire 30 of these fighters with deliveries due to be completed by 2015.

In an unrelated event, the fourth prototype of Sukhoi's developmental PAK-FA/T-50 fighter made a 40minute flight debut from the KnAAPO aircraft plant in Komsolosk-on-Amur on 12 December, this fifth-generation fighter having now completed more than 200 flights since January 2010.

Second batch of Yak-130 combat trainers

The second batch of three Yak-130s manufactured by JSC IRKUT were delivered on 20 November, to the Russian Air Force training centre at Borisoglebsk city. As per a contract signed in December 2011 between the Russian Ministry of Defence and IRKUT Corporation, 55 Yak-130 combat trainers are scheduled to be delivered by 2015 to the Russian Air Force.

Yak-130 Combat Trainer, developed by the Yakovlev Design Bureau, which is an IRKUT Corporation company, is to provide lead-in fighter training for pilots transiting to 4+ and 5 generation fighters. Yak-130 aircraft is the essential component of the integrated training system.

Upgraded Apache helicopter cleared

The US Defence Acquisition Board's decision regarding full-rate production for the Apache Block III helicopter programme was announced by Army officials at Washington, D.C in end-October 2012. Additionally, Apache project manager Col. Jeffrey Hager confirmed that the Apache Block III is being re-designated as an AH-64E model. Upgrades to the aircraft include advanced rotor blades and significantly improved aircraft handling, performance and agility at higher altitudes. Situational awareness is enhanced with electro-optical and infrared sensors for the operational benefit of aviators and battlefield commanders.

Eleven P-8A Poseidons for US Navy

On 21 September 2012, the US Navy awarded Boeing a $1.9 billion contract for 11 more P-8A Poseidon aircraft, which more will take the total fleet to 24 "and bolster the service's anti-submarine, anti-surface warfare and intelligence, surveillance and reconnaissance capabilities". This third low-rate initial production award follows two last year that totalled 13 aircraft. Boeing has delivered three of the production P-8As, which are based on the company's Next-Generation 737-800 commercial aircraft. The US Navy plans to purchase 117 to replace its P-3 fleet.

Colombia orders another Airbus C295

Colombia has signed a contract with Airbus Military for acquisition of an additional C295 aircraft in tactical transport configuration, with delivery scheduled for February 2013. The aircraft will be operated by the Colombian Air Force on military transport and humanitarian aid missions. The new C295 will join four other C295s that the CAF has been operating since 2008. The CAF also operates three Airbus Military CN235-200 transport aircraft.

C-130J-30 and KC-130Js for Saudi

On 8 November 2012, the Defence Security Cooperation Agency announced a possible FMS to Saudi Arabia for 20 C-130J-30 and 5 KC-130J air refueling aircraft, as well as associated equipment, parts, training and logistical support for an estimated cost of $6.7 billion. Saudi Arabia has ordered 20 C-130J-30 aircraft, 5 KC-130J air refueling aircraft, 120 Rolls Royce AE2100D3 engines (100 installed and 20 spares), 25 Link-16 Multifunctional Information Distribution Systems, support equipment, spare and repair parts, personnel training and training equipment, publications and technical data, US Government and contractor technical assistance and other related logistics support.

Delta orders CRJ900

Delta Air Lines have placed orders for 40 CRJ900 regional jets in a deal worth $1.85 billion. The Canadian airframer's regional jet portfolio is facing competition from rival Embraer with its E-Jet range but new orders in 2012 including an 18-aircraft commitment from Gauda Indonesia, have stabilised the programme, raising the backlog to 67 aircraft.

The new sales present a boost for the type and marks a "welcome victory" for Bombardier against its Brazilian rival, which pitched an improved jet for the contest, the E-175+, boasting a 5% gain in fuel efficiency. Delta will use the aircraft, to be configured with 76 seats in a three-class layout, to replace the 60-strong fleet of 50-seat CRJ200s operated on its behalf by regional partners under the Delta Connection brand.

A321neo to 'grow'

Airbus is reportedly examining modification of the A321 fuselage that would potentially increase passenger capacity of the A321neo to 235 seats. The A321s have eight exits, four forward of the wing and four aft and the modification would involve adding another pair of doors, in the form of an overwing exit, and moving the position of the third pair. Airbus has sought to increase seating on the A320 family by redesigning the galley area to use space more efficiently, but seating has remained constrained by exit limits.

Meanwhile, AirAsia CEO Tony Fernandes, while confirming a new order for 64 A320neo and 36 regular A320s, said the carrier was looking at how to "get more seats into the aircraft". AirAsia has opted to stay with the A320, having considered a proposed high-density Bombardier CSeries, which would have been configured with 160 seats. AirAsia is taking options on 50 A321 neos as well as 50 more A320 neos, and will take delivery of the latest 36 A320s up to 2016, while its extra 64 A320 neos will arrive between 2017 and 2021. It already has 200 A320neos on order, which will be delivered during 2016-26.

Turkish Airlines expansion

Turkish Airlines marked the arrival of its 200th aircraft, a Boeing 737-900ER, on 13 November 2012, with a special ceremony at its new hangar at Istanbul/Atatürk International Airport. Turkish Airlines Chairman Hamdi Topcu said, "as a company, we continue to achieve our goals one at a time. We first celebrated the arrival of our 100th aircraft and now we have reached our next goal of 200 aircraft in the fleet. Our next goal, as we continue to expand, is 300. When we began our expansion in 2003, there were only 54 aircraft in the fleet and we flew to 103 destinations. That number is now 205 cities in 90 countries. The fleet in 2003 required only 651 pilots and 1,579 cabin attendants. Those staff numbers have now grown to 2,445 cockpit and 5,344 cabin attendants."

Azerbaijan orders A340-500s

Azerbaijan Airlines intends to acquire two Airbus A340-500s in 2013 in order to launch new long-haul operations. As Sardar Aliyev, deputy chief of the carrier's commercial and tariff policy section stated, "We are planning to operate these aircraft in Asia and America." Azerbaijan Airlines has not identified the two airframes involved, but a pair of A340-500s was recently purchased from Airbus by AJW Capital Partners.

A320neo family aircraft for Pegasus

Pegasus Airlines, the second largest airline in Turkey, has ordered up to 100 A320neo Family aircraft (58 A320neo and 17 A321neo models), of which 75 are firm orders. Pegasus becomes a new Airbus customer and the first Turkish airline to order the A320neo. This is the largest single commercial aircraft

order placed by an airline in Turkey, and was announced on 18 December 2012 at a ceremony attended by Binali Yildirim, the Turkish Minister of Transport, Maritime Affairs and Communication, Ali Sabanci, Chairman of Pegasus, Sertac Haybat, CEO of Pegasus and Christopher Buckley, Airbus Executive Vice President Europe, Asia and Pacific.

Pegasus' new aircraft will be configured in an all economy layout with 180 seats in the A320neo and 220 seats in the A321neo. They will be deployed on Pegasus' rapidly expanding network from Istanbul to destinations in Turkey, Europe and the Middle East.

Bombardier to establish Russian line ?

According to reliable sources, the Canadian Group Bombardier is considering establishing a production line for its Dash 8-Q400 regional turboprops in Russia. The Q400, which undertook an extensive sales tour of the country during spring 2012, is regarded by the manufacturer as "an ideal replacement" for the ageing Antonov An-24 turboprop. The Canadian-built aircraft received type approval from Russia's Interstate Aviation Committee in July 2012, with the first example having entered service with Yakuta Airlines by the end of 2012. The Deputy Minister of Industry and Trade, Yuri Slusar said that discussions were underway to introduce both final assembly and production of some components at the Aviakor aviation plant in Samara.

Expansion for Rossiya

Rossiya has confirmed plans to acquire five 'Russian-built' aircraft as part of its ongoing fleet renewal programme. The carrier, which undertakes transport duties for President Vladimir Putin and other high-ranking officials, has allocated £220 million to purchase three Tupelov Tu-214SRs and two Antonov An-148-100EAs. Delivery of the five jets is expected for completion by 2015. The Tu-214SR is a special radio relay development of the Tu-204 passenger aircraft and incorporates an extensive communications suite along with additional fuel tanks increasing its range to 10,000km. Rossiya's Special Aircraft Division has purchased a number of new types in recent years, including the Airbus ACJ319 and Dassault Falcon 7X, while it has two Ilyushin Il-96-300Pus on order.

Continuous profits for Emirates

The Emirates Group, which owns Emirates Airline and ground handling company dnata, posted a $575million net profit for the first six months of 2012, a 68% increase over the previous year. Group Chairman and CEO Sheikh Ahmed said the company has "continued to invest in the infrastructure of both Emirates and dnata and it continues to pay off." Emirates Airline recorded a first-half net profit of $464 million, which is 104% higher year-on-year.

SilkAir orders Boeing 737s

SilkAir, Singapore Airlines' wholly-owned subsidiary, has finalised an order for 54 Next-Generation Boeing 737 MAX 8s, worth $4.9 billion. The firm commitments comprise 23-800s and 31 MAX 8s, with the carrier having the option of switching to other variants of the aircraft if needed and has also acquired purchase rights against a further unspecified 14 examples. This signals start of the carrier's transition to an all-Boeing fleet and follows a letter of intent for 68 aircraft that both parties signed in August 2012.

SilkAir's Chief Executive Leslie Thng explained that "the capability of the 737s will enable us to spread our wings to even more destinations and increase capacity on existing routes."

Xiamen Airlines joins SkyTeam

Xiamen Airlines, which is China's sixth largest carrier, became 19th member of the SkyTeam global alliance and is the fourth member from Greater China, joining China Airlines, China Southern Airlines and China Eastern Airlines. Xiamen, which flies more than 15 million passengers annually to 50-plus destinations, will bring three new hubs (Xiamen, Fuzhou and Hangzhou) to the alliance, while combining a comprehensive domestic and growing international network. It currently flies to points in Southeast and Northeast Asia and is planning to expand operations to include Europe, North America and Australasia from 2014.

SkyTeam Managing Director Michael Wisbrun said that "by joining SkyTeam, Xiamen opens up the world to its passengers, and we also strengthen the alliance's footprint in China." As Che Shanglun, President and CEO of Xiamen Airlines said, "Members of SkyTeam will enable us to deliver enhanced customer benefits as we diversify and grow our network and this is key to the success of our international routes. Our passengers can anticipate exciting new destinations, while we look forward to a future of co-operation with our partners."

20 CSeries Airliners for Air Baltic

Air Baltic has signed a firm purchase agreement to acquire 10 all-new Bombardier CS300 airliners plus options for a further 10 CS300 aircraft. The purchase agreement represents the conversion to firm orders of a Letter of Intent (LOI), announced at the Farnborough Air Show in 2012. Firm-order contract is valued at approximately $764 million and could increase to $1.57 billion should the 10 purchase rights be converted to firm orders.

GOL Airlines orders LEAP-1Bs for 737 MAX

Brazilian low-cost carrier GOL Linhas Aéreas Inteligentes S.A. have ordered CFM's advanced LEAP-1B engines to power 60 Boeing 737 MAX aircraft. GOL has been a CFM customer since it began operations in January 2001 and the airline has grown into "an agile, innovative airline operating a high-tech fleet of new, modern aircraft". GOL currently offers more than 810 flights daily on 51 domestic Brazilian routes and 12 international destinations, its current fleet consisting of 128 CFM56-7-powered Boeing Next-Generation 737-700/-800 aircraft. The LEAP-1B engine, which is the result of an exhaustive six-year collaboration effort with Boeing, is exclusive powerplant for the new 737 variant, "with the engine uniquely optimised for the airplane". The 737 MAX continues a 30-year relationship between CFM and Boeing; CFM engines have been the sole powerplant for all 737 aircraft sold since 1981.

Kaan Air to acquire 2 AW169s plus AW139

Kaan Air has signed a preliminary sales contract for two AW169 intermediate twin-engine helicopters and a contract for one AW139 medium twin engine helicopter plus further options for both types. The contract marks the entry of the AW169 helicopter into the Turkish helicopter market and the continued success of the AW139 in the Turkish VIP/corporate transport market.

Five additional Bell 429s for Turkey

Turkey's Undersecretariat for Defence Industries has contracted for five Bell 429s, which will be operated by the Turkish General Directorate of Forestry (TGDF) to protect forest resources and coordinate firefighting operations. The TGDF will utilise the Bell 429s to survey and safeguard their woodland resources, comprising 27% of the surface area in Turkey. Upon delivery in early 2014, the new Bell 429s will replace TGDF's existing fleet of helicopters. The TGDF agreement follows the contract with Bell

Helicopter and the Turkish National Police (TNP) for purchase of 15 Bell 429s. These aircraft, scheduled for delivery in August 2013, will carry out a variety of law enforcement missions from surveillance to air support of ground operations.

20 Bell 407GXs for Air Methods

Air Methods have ordered 20 Bell 407GX aircraft, dedicated for air medical transport for critically ill and injured patients throughout the United States. Air Methods, established in 1980, is one of the most experienced air medical operators in the industry,

beginning with a single Bell 206 helicopter in Englewood, Colorado and has since grown to serve 48 states. Air Methods provides air medical transportation for hospitals and communities nationwide and operates eight maintenance centres.

Two AW139s for Brunei Shell Petroleum

Brunei Shell Petroleum Company Sdn Bhd (BSP) has signed contract for two AW139 twin engine helicopters. The aircraft will be used to perform offshore transport missions from Anduki base and are to be delivered in mid 2013. The contract also includes a comprehensive power-by-the-hour support and training package which will be supplied through AgustaWestland Malaysia. Training will also be supplied with a Level D Full Flight Simulator through the Training Academy based in Malaysia.

A350 XWB vertical tail plane livery

The vertical tail plane of the first flyable A350 XWB (MSN1) has just come out of the paint hall in Toulouse sporting the well-known Airbus blue and white livery. This is the first A350 XWB component to be painted in the Airbus livery. The 10 metre tall, composite vertical tail plane is produced, as for all Airbus aircraft, at Airbus' Stade site in Germany. The vertical tail plane is joined to the fuselage using an innovative, lighter connection that is also more aerodynamic.

Rolls-Royce's Trent engines for Singapore Airlines

Rolls-Royce has received a $2.6bn order from Singapore Airlines for Trent engines to power 20 Airbus A350-900 and five Airbus A380 aircraft. The order includes long-term TotalCare® service support.

The Trent 900 powers the Airbus A380 and has been selected by 11 of 17 airlines which operate the aircraft. The Trent XWB, which flew on a flying test bed for the first time in February 2012, will power the Airbus A350. Singapore Airlines is a significant customer for Rolls-Royce and currently operates 19 Airbus A380s powered by Trent 900 engines and 19 Airbus A330s powered by Trent 700 engines. The order for 20 A350-900 aircraft follows Singapore Airlines' June 2007 order of 20 Airbus A350-900 aircraft, taking the total order to 40 A350 aircraft to be powered by Trent XWB engines.

Interjet adds 10 options on order for 20 Sukhoi Superjet 100s

SuperJet International, joint venture between Alenia Aermacchi and Sukhoi Holding have announced that the Mexican airline Interjet, which is the first SSJ100 western customer, have added 10 options to its current firm order for 20 SSJ100 aircraft.

The first 'green' Interjet SSJ100 landed at Venice Marco Polo airport (Italy) on 6 October 2012 for completion and customisation at SuperJet International's facility. The Company is currently developing the EASA STC, Supplemental Type Certification, for the interiors' installation, which will be branded by Pininfarina Italian Style. SJI plans to deliver the first Interjet SSJ100 in March 2013 with a consequent delivery-rate of one aircraft per month.

AirAsia orders 100 more A320s

On 13 December 2012, AirAsia, the largest low cost airline in Asia, placed a new order with Airbus for 100 more A320 Family aircraft. The contract covers an additional 64 A320neo and 36 A320ceo aircraft for operation across the carrier's network.

The contract reaffirms AirAsia's position as the largest A320 Family airline customer in the world. Altogether, the carrier has now ordered 475 single aisle aircraft from Airbus, comprising 264 A320neo and 211 A320ceo. Over 100 aircraft have already been delivered to the airline and are flying out of its bases in Bangkok, Kuala Lumpur, Jakarta, Manila and Tokyo.

Air Astana takes delivery of its first A321

In mid-December 2012, Kazakhstan's flag carrier Air Astana, took delivery of its first A321 from the six A320 Family aircraft ordered in May 2008. The delivery was made to Astana, capital of Kazakhstan and the aircraft will join Air Astana's fleet, which already includes 10 A320 Family aircraft, operated on the airline's domestic and international network.

The airline's A321, powered by IAE V2500 engines, features a two class cabin layout, seating 28 passengers in business class and 151 in economy. Air Astana started commercial service with its first Airbus aircraft, an A320 in 2006 and is currently operating one A319, seven A320s and two A321s.

RR Trent 900 for Japanese A380

Rolls-Royce, has signed a $1bn contract, from Japan's Skymark Airlines for Trent 900 engines to power six Airbus A380 aircraft. The Trent 900 order, which follows the announcement of a letter of intent for these engines in September 2011, includes long-term TotalCare service support. The aircraft will enter into service in 2014.

The airline has also signed a letter of intent for Trent 700 engines to power up to 10 leased Airbus A330s, including TotalCare. The aircraft will be the first A330s in Skymark's fleet and will enter service in 2014. Skymark, a new customer for Rolls-Royce, is the only carrier in Japan to select both the Trent 900 and Trent 700.

ATR delivers first ATR 72-600 in Asia

The first ATR 72-600 has been delivered to Taiwan-based carrier UNI AIR, a regional subsidiary of EVA AIR and entered into service on 11 October 2012, with a first commercial

domestic flight from Taipei to Taidong. ATR launched the ATR -600 series aircraft in late 2007 and this 70-seat regional aircraft variant has been well received worldwide, with some 240 ordered since then. The ATR 72-600 received its EASA-certification in May 2011, thus becoming the world's most-recently certified 70-seat regional aircraft. Among other improvements, it features modern avionics suite, equipped with full-glass cockpit specifically developed for ATR by Thales, and totally redesigned cabin interiors by Italian designer Giugiaro.

40 A320neos for Interjet

Mexican low-cost carrier Interjet signed a purchase agreement for 40 A320neo aircraft, but the engine selection will be announced at a later date. The A320neo has over 95 percent airframe commonality making it an easy fit for Interjet's fleet of 36 A320s. In only seven years of operations, Interjet has become a leading domestic airline in Mexico, having quickly expanded their network throughout the country and into the United States, Central America and the Caribbean. The new A320neo will support their continued network expansion and fleet renewal plans. Interjet has a backlog of 45 A320 Family aircraft, including the current order.

LEAP orders surpass 4,300 engines

An order for 50 LEAP-1C-powered C919 aircraft was announced by COMAC at the Zhuhai Air Show on 14 November 2012, thereby taking total LEAP engine orders and commitments to 4,352 engines at a list price value of more than $52 billion. CFM's LEAP-1C is the sole Western powerplant for the new 150-passenger C919 scheduled to enter commercial service in 2016. Following COMAC's announcement, there are now 760 LEAP-1C engines on order to power 380 C919 aircraft. The LEAP-1B is the sole powerplant for Boeing's new 737 MAX aircraft schedule to enter service in 2017. To date, CFM has received firm orders for 1,876 LEAP-1B engines to power 938 737 MAX airplanes.

The LEAP-1A is one of the engine options for the Airbus A320neo family and 1,192 LEAP-1A engines have been ordered to power 596 A320neo aircraft. This total represents 51 percent of the total A320neo orders for which an engine selection has been made.

First flight of A350 "imminent"

Primary structural assembly of the first flying prototype A350-900 has been completed and transported to the testing station in Toulouse. The twinjet (MSN1) has yet to be equipped with Rolls Royce Trent XWB powerplants, but Airbus aims to carry

out maiden flight of the aircraft around mid-2013. MSN1 is the first of five flight-test airframes which will be constructed and will undergo hydraulic busting at Toulouse's station point, having already completed electrical power-on tests of the fuselage and wings at the station 40 assembly line.

Meanwhile, Airbus has clarified status of the launch customer Qatar Airways' order for the A350, which will take an additional 17 A350-1000s, bringing the Gulf Airline's orders for the variant to 37. Three remaining -800s will be converted to the A350-900, taking the airline's order for the base variant to 43. Qatar's overall order will remain at 80 aircraft. According to Qatar chief Akbar Al Baker, "We have taken the time necessary to come to today's decision in favour of the larger A350 models, which we believe are best suited to our business model."

Airbus chief Fabrice Brégier is quoted as saying that, "this decision by Qatar Airways not only confirms the market trend towards larger A350s, but also demonstrates the value of offering, as we do with the A350XWB, a true family of aircraft from which our customers can select the models that best meet their individual requirements." Qatar's decision marks second order for the redesigned -1000, following Cathay Pacific's commitment to the type in July, and provides crucial backing for the programme. Airbus's backlog for the -1000 is 105.

Neuron in first flight

The multi-national European Neuron unmanned combat air system (UCAS) technology demonstrator made its maiden flight from the Istres test centre in southern France on 1 December 2012. Led by Dassault and France's DGA defence procurement agency, the Neuron project is a 5 tonne-class stealth technology demonstrator powered by a Rolls-Royce Turbomeca Adour turbofan engine (same as powering the Jaguar).

Flight test activities will continue until 2014, when the lone demonstrator will be moved to the Vidsel range in Sweden to undergo operational trials. Later, it will be transferred to the Perdasdefogu range in Sardinia in Italy, where its stealth characteristics will be measured and air-to-ground weapons release activities performed. The aircraft features a smart internal weapons bay developed by Italy's Alenia Aermacchi, which will also contain the target acquisition and communications equipment required to secure approval from a commander in a ground control station before stores release.

Supported by the governments of Greece, Italy, Spain, Sweden and Switzerland, the Neuron programme involves other companies such as EADS, Hellenic Aerospace Industries, Ruag, Saab and Thales.

Meanwhile, BAE Systems aims for the first flight of UK's Taranis UCAS demonstrator by early 2013. The company and Dassault have signed a memorandum of understanding to collaborate on a possible future production of an unmanned strike system for the French and UK defence ministries.

'Grizzly' in milestone tests

Airbus Military has completed critical function and reliability (F&R) tests using the A400M development aircraft 'Grizzly 5', during which the production standard transport was flown for an average of 15 hours per day.

Originally launched in June 2012 but halted for several months owing to faults with Europrop International's TP400-D6 turboprop engine, the F&R process has now accumulated a total of 300 flying hours.

Completing the F&R process was a key requirement towards securing full civil type certification from the European Aviation Safety Agency and initial operating capability clearance from a committee appointed by the defence procurement body. Both milestones are likely to be crossed during the first quarter of 2013 and the company aims to deliver its first production Atlas, (MSN7) to the French Air Force by the end of June 2013.

China to takeover Tu-22M programme?

Consistently over the last seven years, several Chinese websites are reporting that Russia has consented transfer of the Tupolev Tu-22M3 supersonic swingwing strategic bomber programme to China at a reported cost of $1.5 billion. Once in service with the Chinese Naval Air Forces (PLAN) the Tu-22M3 will be known as the 'H-10'.

The Tu-22 will presumably be employed in the low-level maritime strike role where radar detection (and subsequently

interception) will be difficult. With a range of about 6,800 km and a payload of 24,000 kg, a modernised Tu-22M is a significant threat even to contemporary latest-generation weapon systems.

The deal, if it goes through as reported, could represent a significant change in the strategic balance in the region, despite the USA's recent military focus on the Pacific region. The Tu-22M will give China a highly capable asset with which to execute an area denial strategy in the South China Sea and the Pacific theatre as well as a fast platform to launch cruise missiles, conventional or nuclear weapons in various regional war scenarios.

It will be recollected that in the late 1990s, the Indian Navy had been 'offered' the provision of a small number (four) of Tu-22M3s in a package deal alongside the aircraft carrier and nuclear submarines.

MEADS MFCR integration and test series

The first Medium Extended Air Defence System (MEADS) Multifunction Fire Control Radar (MFCR) has been integrated with a MEADS battle manager and launcher at Pratica di Mare Air Force Base near Rome, Italy. The objectives of the integration test series were to demonstrate that the MEADS TOC could control the MEADS MFCR in coordination with the MEADS Launcher. At Pratica di Mare, the MFCR demonstrated key functionalities including 360-degree target acquisition and track using both dedicated flights and other air traffic.

The MFCR is an X-band, solid-state, phased array radar using element-level transmit/receive modules and provides precision tracking and wideband discrimination and classification capabilities. For extremely rapid deployments, the MEADS MFCR can provide both surveillance and fire control capabilities until a surveillance radar joins the network. The MFCR uses its main beam for uplink and downlink missile communications and an advanced Mode 5 identify friend-or-foe subsystem supports improved threat identification.

Typhoon launches MBDA meteor

The Eurofighter Typhoon has 'released' an MBDA Meteor beyond visual-range air-to-air missile for the first time, the milestone having been achieved over a UK test range. Flown by a BAE Systems test pilot using the UK's Typhoon Instrumented Production Aircraft 1, the test included ejecting a telemetry-equipped trial round from a rear-fuselage missile station over the Qinetiq firing range off Aberporth, west Wales.

"The missile motor was fired, providing data that will allow the missile launch envelope to be expanded," according to Eurofighter. The weapon is powered by a scramjet rocket developed by MBDA Germany subsidiary Bayern-Chemie. Being integrated as part of a future enhancements programme for the Eurofighter, Meteor is designed to be European successor to the Raytheon AIM-120 AMRAAM, which currently arms the type.

Meteor will enter operational series with Gripen fighters in 2014-15, before operation with Typhoons of Germany, Italy, Spain and the UK, as also the French Dassault Rafale. A series of 21 development and test firings have previously been performed using a Gripen testbed and a Panavia Tornado F3 trials aircraft.

Northrop Grumman's B-1 radar mod kit

Northrop Grumman Corporation has delivered the first B-1 bomber radar prime mission equipment kit under a series of US Air Force contracts worth a combined total of $161 million for the B-1's Radar Reliability and Maintainability Programme

(RMIP). The US Air Force awarded Northrop Grumman a $65 million RMIP base contract in September 2010 for 22 modification kits, along with test benches, spares, repairs, technical data and services. Options worth an additional $95 million have since been awarded for another 38 kits. The RMIP replaces two line-replaceable units in the B-1's AN/APQ-164 radar to improve both its reliability and maintainability.

GE Aviation's ADVENT programme

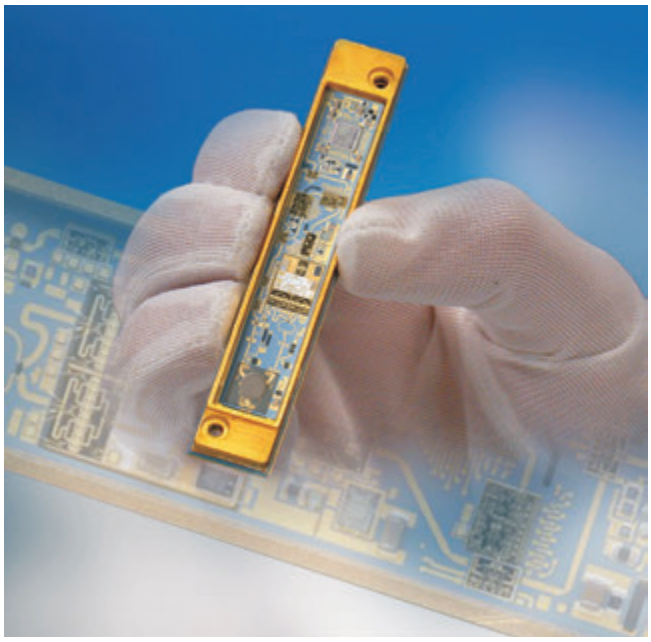
GE Aviation has begun testing its engine core for the ADaptive Versatile ENgine Technology (ADVENT) programme with the US Air Force Research Laboratory. The core test demonstrates GE's most advanced core propulsion technologies including lightweight, heat-resistant ceramic matrix composite (CMC) materials. These core technologies, along with an adaptive low pressure spool, will result in a 25 percent improvement in fuel efficiency, a 30 percent increase in operating range and a five-to-ten percent improvement in thrust compared to current fixed-cycle engines.

The ADVENT programme is scheduled to conclude in 2013 with a full engine test. GE will continue to mature the ADVENT technologies through the Air Force's Adaptive Engine Technology Development (AETD) programme, which will conclude in 2016, following fan rig testing and a core engine test.

Cassidian's radar technology

Cassidian reiterated its leading position in state-of-the-art radar technology by developing a new generation of transmit and receive modules, which give the new AESA (Active Electronically Scanned Array) radars electronic beam scanning previously unattained performance. Thanks to the new modules, the multi-mode and multi-tasking capabilities of AESA antennas can be enhanced on a sustained basis while at the same time significantly reducing production costs. In contrast to conventional systems, radars based on AESA technology can perform several tasks virtually simultaneously. The transmitting energy is generated directly in the antenna, namely in a multitude of transmit and receive modules (TRM), instead of in a delicate central transmitter.

With environmental qualification to IEC 60748, Cassidian now has completed basic development of a new generation of transmit and receive modules. This milestone will pave the way for using these high-tech components in particularly demanding applications in the aerospace sector. The new technology offers operational advantages and Cassidian expects AESA radars to be employed in many fields of reconnaissance and surveillance in future. The Cassidian products using the new TRMs include the Eurofighter's future e-scan radar, the security radars in the Spexer family as well as spaceborne earth observation radars.

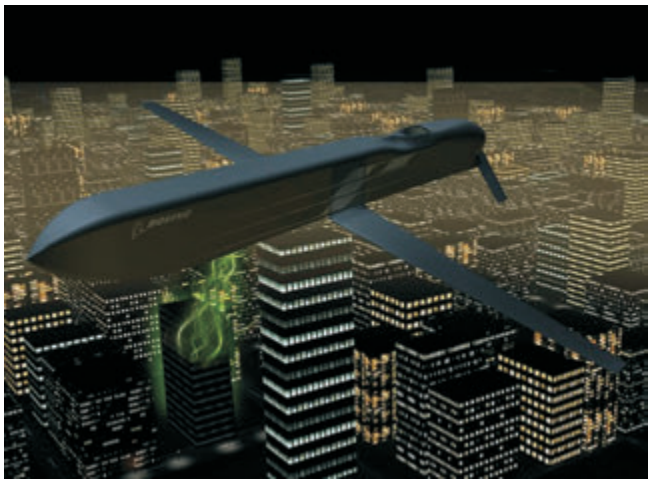


SELEX Galileo in export contracts for InfraRed detectors

SELEX Galileo, a Finmeccanica company, has been awarded contracts to supply InfraRed (IR) detectors to export markets including the USA, Russia and Singapore. SELEX Galileo will deliver their Hawk, Osprey S, Eagle, Condor II, Merlin and DLATGS detectors for a range of applications including airborne search and rescue, air traffic control, handheld cameras for border security, long range surveillance systems and IR spectroscopy. "The company's engineers have been working closely with customers to ensure that the most effective detector is chosen for the each application".

Boeing CHAMP in flight test

Boeing and the US Air Force Research Laboratory (AFRL) Directed Energy Directorate at Kirtland Air Force Base, N.M., successfully tested the Counter-electronics High-



powered Microwave Advanced Missile Project (CHAMP) during a flight over the Utah Test and Training Range that was monitored from Hill Air Force Base. CHAMP, which renders electronic targets useless, is a non-kinetic alternative to traditional explosive weapons that use the energy of motion to destroy a target. During the test, the CHAMP missile navigated a pre-programmed flight plan and emitted bursts of high-powered energy, effectively knocking out the target's data and electronic subsystems. CHAMP allows for selective high-frequency radio wave strikes against numerous targets during a single mission.

Cassidian naval radar for Finland

Cassidian will equip new Offshore Patrol Vessels of the Finnish Border Guard with its proven TRS-3D naval radar. The STX Shipyard in Rauma/Finland has awarded Cassidian contracts to

deliver the radar by mid-2013 for integration into the new ship. The radar is intended to provide a comprehensive situation picture as well as safe helicopter guidance and Search-and-Rescue (SAR) missions under the extreme environmental conditions of Finnish littoral waters. TRS-3D is a 3-dimensional multimode naval radar for air and sea surveillance and includes the ability to correlate plots and tracks of targets with Cassidian's MSSR 2000 I identification system for automatic identification of vessels and aircraft. TRS-3D is in service with Squadron 2000 patrol vessels and the *Hämeenma*-class ships of the Finnish Navy.

SELEX Galileo Janus turrets for Malta

SELEX Galileo has been awarded a contract by the Maltese Armed Forces to deliver two Janus Naval (Janus-N) electro-optic observation and fire control panoramic sights. The sights will be installed on patrol boats operated by the Armed Forces of

Malta. The Janus-N, derived from the successful Janus land sight, has been steadily gaining interest on the international market and is currently in service with patrol units of the Italian Navy and used for day and night-time maritime surveillance. The Janus-N features a stabilised multi-sensor turret that contains a day (TV) camera, a night (IR) camera and a laser rangefinder to detect distances of targets under observation. A console allows the operator to manage the various modes of the system and the open-architecture of the Janus-N allows it to be integrated with the existing command and control systems on-board the ship.

Thales sonars for French and Italian FREMM frigates

The official qualification trials of sonars for the FREMM frigate programme took place over a six-week period in June and July 2012 on the FREMM frigate Aquitaine in the Bay of Biscay. The successful trials are culmination of nine months of testing with the UMS 4110 CL bow-mounted sonar and CAPTAS 4249 towed-array sonar, which have now achieved Level 1 at-sea qualification. The qualification trials covered the active, passive and obstacle-avoidance functions of the sonars and were conducted for DCNS, the European armaments procurement agency OCCAR, the French Defence Procurement Agency (DGA, *Direction générale de l'armement*) and the French Navy.

The CAPTAS 4249 sonar is based on very low-frequency passive and active arrays to provide operators with an exceptional reach on silent targets. It is equipped with a quick deployment system for lowering it into the water. Its long-range detection capability will allow FREMM frigates to maintain a tactical advantage over submarines. Thales has more than 20 years' experience in this field and is the world leader in very low-frequency variable-depth sonars.

DCNS delivers first FREMM frigate

On 23 November 2012, European Joint Armament Cooperation Organisation OCCAR formally accepted the FREMM frigate *Aquitaine*, which is the first FREMM multimission frigate for the French Navy. The Group's employees and partners worked together to apply their know-how to the construction of this first-of-class vessel, the DCNS teams achjieving all milestones until the *Aquitaine* was floated out of the building dock in April 2010 then set sail for her first sea trials in April 2011. FREMM multimission frigates are designed for multirole missions including anti-submarine and anti-surface warfare and for subsequent upgrades to the land strike and air defence roles.

DCNS and MBDA innovative weapons

To meet the requirement for air defence of naval submarines, DCNS in cooperation with MBDA is now proposing a weapon system which will be available in two

versions: mast-mounted anti-aircraft self-defence system (designed for incorporation in the fin of a submarine, which comprises a retractable mast supporting a turret containing several Mistral short-range missiles) and self-defence system with an undersea vehicle (an undersea vehicle (UUV), inside which is a Mica medium-range missile, is deployed from a torpedo tube). These weapon systems are integrated within the Subtics combat system, thereby ensuring the submarine's overall performance from target acquisition and missile launch to target reach.

NGC and ITT Exelis partner for NGJ

Northrop Grumman Corporation and ITT Exelis have teamed to provide unique solutions for the US Navy's Next Generation Jammer (NGJ) programme. Both companies

have been involved in electronic warfare and airborne electronic attack technological development since the 1960s, making them "well positioned to compete for the next phase of this critical naval warfighting capability that is the Technology Demonstration phase". The Navy's NGJ will fly on the EA-18G Growler as the newest, most advanced electronic attack aircraft in the world, and will provide US forces with the ability to suppress and defeat enemy integrated air defence systems and disrupt and disable an enemy's ground-based communications capabilities.

Northrop Grumman is leveraging four decades of expertise in designing, developing and delivering advanced weapons systems that support the customer's electronic warfare and airborne electronic attack missions. Exelis is extremely customer-focused in this mission area and will support continued development of advanced technologies to identify and respond to threat emissions and recently fielded the Universal Exciter Upgrade for the existing AN/ALQ-99 Tactical Jamming System, which has significantly expanded its capabilities.

LITENING SE Targeting Pods for US Air Force

Northrop Grumman Corporation has received a $71.5 million order from the US Air Force to begin full-rate production of LITENING SE advanced targeting pods and spares for the Advanced Targeting Pod – Sensor Enhancement (ATP-SE) programme.

The LITENING SE pylon-mounted targeting pod is capable of producing infrared and visible imagery of both airborne and ground targets, enabling pilots to detect, acquire, auto-track and identify targets for accurate delivery of both conventional and precision-guided weapons. The pod provides laser ranging and designation to support weapon delivery, navigational functions, recording and data-linking of generated imagery and data.

Building on the successful LITENING G4, the enhanced LITENING SE includes technologies such as true 1kx1k forward-looking infrared and charge-coupled device sensors, short-wave infrared laser imaging sensor, colour symbology, tracker improvements, enhanced zoom and two-way multiband data link. These advancements deliver more accurate target identification and location at longer ranges than previous generations of LITENING targeting pod systems while reducing pilot workload.

The HPT-32 Grounding

An alternate logic

'Dented and painted' HPT-32 at an Aero India show

The recent article in *Vayu* V/2012 'Requiem for the HPT-32' was carefully researched and provoked much thought. The fuel divider and the collector tank location and capacity are the prime suspects. However there still appears to be some uncertainty : the fuel divider was taken off the list of suspects by investigators and there was the case of an engine stoppage while on the ground.

There is a certain uncertainty. It is true that unless the fuel supply is smartly cut off, a warm fuel injected engine will continue to 'diesel' even after the ignition is shut off. This 'cut off' is one of the major functions of the fuel divider. However this function "gets out of the way", so to speak, when the throttle is opened beyond idle or near idle. If the fuel divider is the culprit, all the seventy odd incidents of engine stoppage would have occurred at idle or near idle conditions. Also, if maintenance is a problem NO failures should have occurred with a new or "not overhauled" fuel divider. Has this been the case?

Regarding the fuel pipe line being not as per FAR standards, the standard requirement is that the pipeline should be able to handle one and a half times the TO fuel flow rate. For the engine in question, the TO fuel flow is approximately 1.3 litres per minute or 20 ml per second corresponding to fuel flow velocity of about 0.7 metres/sec which is not too bad. In any case the main restriction to flow would be the filter just upstream of this line. Actually at the idle case, the fuel flow would be around 200 ml per minute so both the usable header tank capacity and the pipeline are unlikely to be prime suspect. By my estimate, even with the usable 3.5 litre the engine could chunter on for a quarter of an hour at flight idle or three minutes full power, both being times more than enough to get the aeroplane at least into level circuit if not land. That too under flight conditions of no bank or turn during the descent because a bank would recharge the header !

It is also to be noted that there was an engine stoppage on the ground, when the aeroplane was near as level and feed / collector capacity problems could not have occurred. Finally it is bemusing to accept a failure rate of 77 failures in 400,000 flight hours and that too in a system that is 'on' every minute of the flight if a single component or system is at significant fault. In my view there is clearly room for an alternate hypothesis.

Let me state my *Mea Culpas* right in the beginning. I had no chance to see this aeroplane or have access to the data and my hypothesis is based entirely on conjecture and my experience as an Engineer. Starting point of the alternate construct is that considering usage, the rate of failure is very low. Could the failure be due to the fact that there are a fairly large number of random factors which almost never occur at the same time. However, when they do occur together, they cause an engine 'failure'. The 'rare random combination' better explains the one failure every 5000 hrs.

What could be these factors?

✈ The poor engine is suffering from 'glider tug' syndrome. A high power–low air speed combination as in towing gliders have been known to cause engine failure. The HPT-32 does not tow gliders but it is an extremely 'draggy' aeroplane. If you visually compare the HPT-32 with the similarly powered Grob 120A you will get the point. If you are one of those who will point out that the Germans will get "style" into concrete "tie down" blocks then look at the Finnish Vinka or even the Bravo or the Bulldog. In the HPT-32, the contours of the cowling and the canopy, the untidy undercarriage linkages and the huge fin are actually offensive to the eye. One must particularly mention the oversized fin. The excess wetted area results in excessive parasite and

induced drag leading, again, to an overworked engine. The engine has to operate at a few notches higher throttle setting compared to other installations and yet not get enough cooling air.

- Cooling of the last row of horizontally opposed engines requires, as the Germans say, 'patience, experience and maturity'. The rearmost cylinder opposed to the direction of the propeller rotation particularly is, cooling wise, in a severely unfriendly environment. Thus fitment of the cooling baffles and its maintenance is of greater than usual relevance in this case.
- In India the cooling air itself is 20 to 25 degrees higher than ISA, which would rob it of about thirty percent of its cooling capability. If this is combined with the occasional less than 'normal' humidity, we can see problems lurking around the corner. I dare say that if the HPT-32 operated above 35° C we may not have had this problem at all !
- The dust and the dirt. The metered fuel supply system takes input from the static and rams pressures. If this is not 'klim bim' perfect then the mixture would lean out to the point when the engine would starve and stop. Dust would also reduce the cooling heat transfer.
- So what could really be happening? We have an older (somewhat dented and battered and the cowling and canopy rattles a bit in flight !) aeroplane flying a sortie on a dry dusty day with some prolonged spirited flying at high power. The engine is hot. As the power is reduced and the aircraft is gliding back, the cooling flow is reduced by the low airspeed; the heat accumulates under the cowling. Perhaps the baffle seals are just a little aged. All these add up to (in those rare occasions) local overheat, distortion and 'incipient seizure' in the engine. The high oil temperature and hence reduced viscosity of the lube oil, would be additional contributor in this construct.
- For reasons too boring to detail here, I once had a car that had clocked 90,000 kms. It had this trick of the engine suddenly 'seizing' yet when I let the old girl be for some time (and this was in Daman where chilled liquid coolants for me were easily accessible) it would restart as if there had been no quarrel. There was another case when a students' designed racing car would stop suddenly due to over heating. A better designed duct for the radiator cured the problem very satisfactorily. Perhaps the HPT-32's engine is having the same problems?

The 'old world' cockpit of an HPT-32

Under chairmanship of Air Marshal Lakshman Katre, HAL worked on the HTT-34 turboprop variant but this was foreclosed after his move back to the IAF as CAS.

The Grob 120 A is used for basic flying training by several leading Air Forces of the world.

- Incidentally the HPT-32's wing and span loadings are some 40% higher than the HT-2s and so the glide ratio and minimum airspeed would be that much poorer. At low altitudes the pilots have that much less chance of a safer landing or a pancake.

If the above construct is a possible model then what is to be done?

In the immediate term:

- Increase the routine maintenance quality. The baffling of the engine is a prime suspect and so must come for close inspection at suitable intervals. Cylinder fins and the static and pitot ports for the AF system to be checked for dirt and should be inspected for cleanliness as per flying conditions. I mention routine maintenance and preflight checks only because a recent issue of a NTSB bulletin records the fatal crash at take off killing six people because the pilot had failed to drain the fuel tanks of accumulated water. In his previous company, someone else used to do this for him.
- Quality of fit of the cowling and the canopy joints and panels must be improved by the fitters to the extent possible to reduce drag. Older airframes should be examined for the usual dents, bumps, loose fittings with the above prognosis in mind.

In the medium term the following studies to be made.

- An OR study into the accidents based on the above assumption that "an unfortunate combination of circumstances" rather than major system fault is the cause of the "engine failure".
- Initiate design of a neater cowling and canopy. The cowling lines of the Italian SF 260 (which incidentally has the same engine) is the work of a Past Master (Stelio Frati) and could be an inspiration. These could be retrofitted at the FTS.
- Do a CFD study of the through flow and back flow on the oil cooler. I have seen significant improvements with some very simple 'fixes' and better lubricant viscosity would be a definite palliative.
- Conduct a study to find out how difficult it would be to fit a semi-retractable undercarriage as in the Yak-18, and if there would be any benefits.

The real 'de luxe' solution is economically unviable but is mentioned for completeness of the discussions. It is entirely a personal view that HAL spoilt itself by the success it had with the big fin to improve the spinning characteristics of the HJT-16 which I have seen has very reliable spinning characteristics. What worked for the Kiran was possibly tried again on the HPT-32 but the balance was lost. Optically the HPT-32's fin is huge resulting in excessive weight and drag. Others rely extensively on strakes to generate flow across the fin and rudder in a spin. The German Grob 120 is typically Teutonic in its determined application of strakes and under fins but the Bulldog, and the Vinka not to mention the SF-260 all use strakes quite discreetly with success to achieve desirable spinning characteristics. The gains of using strakes for good spin recovery are in weight and drag which seems to be the root problem here.

Professor Prodyut Das

The Siai Marchetti SF 260 was briefly evaluated by the IAF in 1978 but 'lost out' to the indigenous counterpart.

Grob's G.120TP turboprop basic trainer is considered a 'game changer' and was cursorily evaluated by the IAF for meeting its basic training aircraft (BTA) requirement in 2011.

Italian CH-47C Chinook

Exercise Green Blade 2012

A joint exercise 'Exercise Green Blade' was organised by Belgium and supported by Luxemburg between 18 September and 5 October 2012, and held under the auspices of the EDA (European Defence Agency) Helicopter Training Programme. The airfield of KleineBrogel, home of the 10th Tactical Fighter Wing and situated about 13 km from the Dutch border in the north-east of Belgium, served as hub for all rotary-wing operations.

Green Blade is the latest in a series of increasingly effective helicopter exercises, held in France, Spain, Italy and Portugal since 2009 under the Helicopter Exercise Programme. These joint exercises aim to incorporate the lessons learnt and enhance helicopter deployability for the member states, and save the individual EDA states effort and resources which can be used for other investments in the defence sector. As Peter Round, EDA Capabilities Director explained, "We fight together, so we have to work together, pooling our resources. An exercise like this is the best way to deliver high quality training in these challenging times."

A total of 15 helicopters were deployed at Kleine Brogel Air Base, comprising transport (Italian CH-47C Chinook), utility (Belgium A109 and German UH-1D) and attack helicopters (Italian A-129CBT). These worked together with other air assets like F-16s, C-130s and Belgium UAVs (B-Hunter) to make the scenario more realistic. Unfortunately, the scheduled NH90s from Germany and Italy could not participate.

Running parallel with *Pegasus*, a biennial Belgian exercise for Special Forces, the two groups worked closely together on numerous missions. "Combining both exercises is very cost effective and it offers excellent training

Italian A-129CBT Mangusta of 49° rSqA

Italian A-129CBT (Photo: M. Bartwicki)

opportunities for both the helicopter crew and Special Forces." With the helicopters from Belgium, Germany and Italy, the two exercises involved 550 personnel from five countries, the participant countries being Belgium, Germany, Italy, Luxembourg and Spain as EDA member states and Canada for the *Pegasus* exercise.

Exercise *Green Blade* followed a "step by step" approach and the programme consisted of three major consecutive modules. During the Combat Enhancement Training / Force Integration Training (CET/FIT) module, the helicopter units familiarised themselves with the exercise framework (Belgian airspace, air rules and exercise-specific operating procedures), performed cross-training (rehearse common drills, techniques, tactics and procedures between helicopter units as well as supported ground units) and the opportunity to perform non-tactical training flights (NVG, Nap of Earth).

During the second module, the units had the opportunity to analyse, plan and execute a wide variety of Special Forces related missions (insertion/extraction, hostage rescue, personnel recovery). When requested by the participating nations, the more traditional helicopter missions such as airmobile operations (seize and hold), MedEvac, Recce & Surveillance were also implemented. In this phase, all flights were flown from deployment operating base (DOB) Kleine Brogel to Leopoldsburg barracks with the exercise areas situated in the North of Belgium.

Belgium A109 (Photo: M. Bartwicki)

During the last module, the nature of flights and missions were similar to the previous module but the helicopter units were temporarily deployed to a Forward Operating Base (FOB) which was situated in the south-east of Belgium. Furthermore, the helicopters had the opportunity to perform a Forward Arming and Refueling Point (FARP) procedure at this FOB. Scenarios were now more intense and complex than in earlier modules.

Two interesting and rarely seen participants in Northern Europe were the two A-129CBT Mangustas of 49º rSqA and two CH-47C Chinooks of 11ºGrSqA. The detachment consisted of 80 personnel of which 16 were pilots. Lt Col Massimiliano was the detachment commander of the 49º Stormo Task Force for the *Green Blade* exercise and normally based with the A-129s at Casarsadella Delizia in Northeastern Italy.

Being based just south of the Alps in Northern Italy, the commander commented on the contrast with the Belgium landscape, "In Italy we are used to mountainous terrain with hardly anything to take into account. Here in Belgium the ground is generally flat with populated areas and structures like power plants to avoid. Only the southeast of Belgium with its hills and low population density resembles Italy".

He went on to explain, "*Green Blade* is a great exercise for us to show other member states capabilities of the A-129CBT Mangusta. It allows our younger, less experienced pilots to experience the complexity of operations and also benefit from this exchange of expertise. Coping with challenging weather conditions, like regular thundershowers in the second week of the exercise, is a good learning process for our detachment."

"The aim of the exercise is to create better understanding and trust

between European crews and improving interoperability. The exercise was a major success as around 487 hours worth of flying was accomplished and 49 multinational missions were launched. Crews were exposed to the complexities of multinational operations and many had the opportunity to lead a multinational formation for the first time."

Michael Becker, responsible for *Green Blade* 2012 at the EDA, declared the exercise to be "a great success," lauding the hard work and passion displayed by the participants. Andy Gray, in charge of EDA's helicopter training programme added, *"We have to train personnel the way we fight. Collaboration is the only option and Green Blade was an excellent example of how far we get by working and training together."*

Green Blade was the fifth in a series of exercises in the European Defence Agency's Helicopter Training Programme. Each of these has provided new opportunities and played a part in ensuring that the programme evolves, remains relevant and provides the participating nations the essential training they need.

All photos (except where mentioned) and text by Remco Stalenhoef, Patrick Smitshoek and Stephan van Geem

German UH-1D returning from mission. Photo: B. Rosselle/BAF

Special forces parajumping from a Belgium C-130 Photo: B. Rosselle/BAF

Three German UH-1Ds in formation. Photo: B. Rosselle/BAF

An USAF A-10C of the 81st Fighter Squadron.

Ramstein Rover 2012

CAS is King !

Between 4-21 September 2012 exercise *Ramstein Rover* (RARO12) took place, the biggest NATO exercise of 2012 and held at Namest Air Force Base in central part of the Czech Republic. The area around Namest nad Oslavou provides an excellent location for this exercise for three reasons according to Lieutenant General Ploeger, Deputy Commander of Allied Air Command Ramstein, Germany: "First, being in the heart of Europe, if you will, it reduces transportation costs for the nations to come here. Second, it is perfectly situated between two military training areas with ranges for us to conduct the training. Third, the airbase has excellent facilities available." Earlier, the 2010 edition of *Ramstein Rover* was conducted at Volk Field, Wisconsin in the United States.

"The aim of RARO12 was to provide a measurable increase in proficiency, standardisation and interoperability for Forward Air Controllers (FACs) from NATO, Partnership for Peace (PfP) and International Security Assistance Force (ISAF) troop contributing nations" according to Exercise Director Colonel (GS) MSc. Harry H. Schnell. "RARO12 is a live-fly exercise during which NATO aircraft will provide the full-spectrum of day, night, medium and low altitude training for aircrews in realistic and complex scenarios". In a classroom academic training followed by live-fly practical Close Air Support (CAS) training, RARO12 exercise participants have been taught how to effectively employ airpower in support of their own forces while mitigating risks to civilians and their property.

Forward Air Controller (FAC) or in US terminology, Joint Terminal Air Controller (JTAC) is currently one of the hottest topics not only for NATO but also for other ISAF-contributing nations. At this time some 350 controllers currently support troops in the ISAF theatre of operations. It is obvious, as the operational tempo has increased, that there is a shortage of such controllers. Air Command (AC) Ramstein formed a Forward Air Controllers Capability Branch (FCB) after an incident during 2006 in Afghanistan. The FCB, which is part of the ISAF Cell of AC Ramstein consists of four teams. The personnel for these Teams are provided by four NATO nations (United Kingdom, Italy, Germany and the Czech Republic).

Participants at RARO 2012

Aircraft type	Unit	Country
L-39ZA	222 squadron	Czech Air Force
Mi-35	221 squadron	Czech Air Force
Mi-171	231 squadron	Czech Air Force
L-159/T1 (flying from Caslav AFB)	212 squadron	Czech Air Force
L-39ZAM	2 squadron	Slovak Air Force
Mi-17M		Slovak Air Force
PC-9	--	Equipment Interior Services (E.I.S)
LJ-35	--	Gesellschaft für Flugzieldarstellung/Target Towing Company (GFD)
F-16C	181 FILO	Turkish Air Force
A-10C	81 Fighter Squadron	USAFE
B-52H (only 18 September)	343d Bomb Squadron	AFRC
KC-135R (flying from Mildenhall)	100 ARW	USAF

The four teams as part of FCB are the following: The FAC Standardisation Team which concentrates on standardisation issues to accredit national Air Ground Operational Schools (AGOS) and FAC/JTAC simulators; the Pre-Deployment Training Team focuses on activities connected with pre-deployment assistance to the nations and development of particular ISAF academics; the Sustainment Team's main task is to monitor the number of FAC/JTAC which are current and ready for operational use throughout NATO (coordinates national sustainment efforts by liaising between different national organisations to ensure the delivery of more effective training) and finally, the Mobile Training Team which supports nations with supervision and assistance of their own training programmes. It is obvious that all this could not be done by AC Ramstein alone. Support is provided by the United States Air Force Europe (USAFE) Air Ground Operations School (AGOS) and the Warrior Preparation Centre (WPC), which have been key in the success of the work undertaken in this area.

Exercise *Ramstein Rover* 2012 (RARO12) is an advanced training

Czech Air Force Mi-35 of 221 Squadron.

opportunity to exercise CAS and FAC capabilities. RARO12 provided realistic pre-deployment training for FACs to be deployed to NATO's ISAF operations in Afghanistan. In coordination with the Czech Air Force, HQ AC Ramstein had organised the exercise for participants from a total of 16 NATO member nations based at Namest Air Base and involving training areas in the Czech Republic at Libava, Boletice and Písek. During RARO12 the Czech Air Force also flew missions out of Čáslav Air Force Base. Flying assets, FAC teams and observers were provided by the Czech Republic, Belgium, Estonia, France, Germany, Greece, Italy, Latvia, the Netherlands, Norway, Poland, Slovakia, Slovenia, Turkey and the United States.

The Czech Armed Forces, as part of Forward Air Controllers Capability Branch (FCB), had been very keen on hosting the exercise. "We have learned

Czech Mi-171


Turkish AF F-16Cs and a lone L-39ZAM of Slovakia.

a lot" according to Captain Jan Pribyl, a pilot of 212 squadron flying the L-159 ALCA. "Compared to normal CAS/FAC exercises we had many more aircraft in the air". In order not to put additional pressure on flight crews the majority of the CAS missions where conducted at medium level flying. "Normally we fly low level when working with the FAC/JTAC" according to Captain Pribyl. "We as a squadron are also involved in training exercises conducted in Germany at the US Army ranges in Hohenfels and Grafenwohr; we are expanding our CAS skills as an unit". To date 212 squadron has no dedicated targeting pod available for the L-159. Aero Vodovochy, manufacturers of the L-39/ L-159, has been starting with testing


Turkish Air Force F-16C

of the Litening 3 (AN/AAQ-28V) pod. For testing purposes the sole L-159B was being used. “We hoped to have a targeting pod acquired already in 2009, however funding was not approved at that time” Capt. Pribyl continued. “We need a targeting pod to further increase our skills; so far we have to rely on our own eyes when involved in CAS missions” Captain Pribyl concluded.

One of the largest aircraft to participate in RARO12 was the B-52H from the 343d Bomb Squadron based at Barksdale Air Force Base, Louisiana in the United States, the sole nuclear capable squadron in the Air Force Reserve. The aircraft joined the exercise for 40 minutes when on its way to the NATO Airdays at Ostrava airport. Crewmember Captain Andrew Marshal explained, “We can link up with FACs/JTACs on the ground. Higher

PC-9 of E.I.S.

A- 10C of the USAF

employment altitudes, increased time on station, and the variety of weapons available to the ground commander make the B-52 an excellent CAS platform. Having the ability to link our targeting pod feed with the FACs/JTACs also provides us a broad overview of the battlefield.” Captain Marshal. “The link provides an avenue for the controller to direct our pod to a specific area of interest and provide real-time time information. This information can be used for ISR purposes or positive identification of the intended target.”

“The biggest challenge for us in dynamic environments such as CAS is the fact that most of our planning occurs much earlier than everyone else involved. RARO12 was no exception. Much like real life, deployed from a FOB and had to adapt to significant changes to the game plan.”

“During the mission we worked with FACs from Turkey supported by an instructor from Latvia. Joint standards used in training and real life has made working with multi-national forces much easier. Each student was able to focus their training on CAS check-in procedures, providing a situation update, and passing a

A- 10Cs lined up

couple of 9 line targets each". The 9 lines are a clear and precise method to transfer targeting information between controllers and aircrew. Each line contains specific information that is used to identify targets and avoid unnecessary collateral damage.

Captain Marshall continued, "We started with a CAS check in, then the so-called 9 line targeting information. This means we receive detailed information on the target, this in order to avoid unnecessary collateral damage. Information shared is short and easy to understand for us. During our runs on the range employment of GBU-31 JDAM, GBU-12 Paveway II, and Mk82s were simulated as the B-52s have not been carrying live ammunition during their stay in Europe".

The B-52 currently employs the Litening ATP and will introduce the Sniper ATP some time in 2013. Sniper will initially bridge the gap while the current Litening pods receive the G4 upgrade and should remain an option in the arsenal after the upgrade is complete.

The FAC Capability Section (FCS) of HQ AC Ramstein had been responsible for the FAC training during the RARO12 exercise. The team led by Lieutenant Colonel Steve 'Cajun' Behmer, a US

Turkish F-16C takes off

Aero L-159s of the Czech AF

Air Force A-10 pilot, had been working the standardisation of NATO's FACs and, using this process, had accredited several FAC training facilities. "RARO12 provides a great venue for 'collective' training," according to Lt Col Behmer, "an aircraft mission in support of ground forces – what we call CAS – is typically a combined and joint event. It involves several nations and branches of the military within those nations. A CAS mission provides our men on the ground – the FACs who direct and control the supporting aircraft to the target – with a very beneficial opportunity to exercise with these entities."

After three weeks of exercise activities and more than 500 sorties, some 1150 Forward Air Controller control runs and an average 20 control runs for each of the 51 international FACs, made up the balance of exercise RARO12. "However, this is only one side of the medal", Exercise Director Colonel (GS) MSc Harry H. Schnell explained after conclusion of the flying part, as clear progress had been made in the standardisation of FACs, mutual understanding, and the capability for air-ground-integration. "It is now a question of assessing and analysing the achieved results to deduce further areas of improvements". The key aspects of RARO12 had been achieved," the exercise Director continued, "we have successfully attained military goals, prevented collateral damage in our scenarios and ensured appropriate protection of own forces. And this is also what matters in real-world operations. We provide to our soldiers the best training currently available. In line with the Alliance's principle to "train as we operate" the RARO12 exercise scenario was not a fictitious one. We conducted exercise operations day and night and in challenging weather to prepare our soldiers for their missions based on our experiences made in the ISAF operations" Colonel Schnell concluded. "It is vital to enhance the same level of standard for this special capability among NATO nations and to maintain it for future Alliance missions."

RARO 2013 is expected to take place again at Namest Air Force Base. However a final decision is still to be taken.

Carlo Kuit & Paul Kievit/
Bronco Aviation

Czech L-39ZA comes in to land.

Ancient Aviator Anecdote

A GIFT OF MEMORY

Post retirement, my wife and I have been frequent visitors to the UAE to spend time with our children in Dubai and Abu Dhabi. Over the past quarter of a century we have been witness to the conversion of liquid underground wealth into the splendid architectural marvels that dot its landscape, the international goods and services in a medley of malls, the country's enviable infrastructural growth and a lifestyle with a western patina. The creation of this miracle in the desert is due to vision, technology and manpower skills from 202 nationalities that live and work in the UAE. Expatriates vastly outnumber Emiraties and include over two million of my own countrymen (and women) whose labour in the sands of Arabia has created much prosperity in various towns in India.

More memorable than the impressive edifices however are the ordinary people we meet. People : the Bangladeshi cab driver who, when I addressed him in Bengali, went out of his way to help us locate our destination; the Gujarati lifeguard at the swimming pool who, learning I was born in Anand and spent part of my childhood in Surat (his home town), greeted me thereafter with folded hands and a cheery 'Namaste Dadaji' every morning; the Filipina lady photographer and her colleague at the Burj Khalifa who broke into a spontaneous rendition of 'Happy Birthday' on learning it was my wife's birthday; our dignified Pakistani driver, overhearing my post-lunch regret at the non-availability of meetha paan (banned in UAE) who produced a substitute digestive the next day; the Jordanian oil engineer with a Chinese wife whose two little girls get along happily with our youngest granddaughter from London with her Indian name and her English accent; the Emirati airline staff checking us in, on seeing our destination, enthusiastically exclaimed, "Ah Hyderabad……..Biryani Biryani !"

Our evenings in Abu Dhabi invariably include a walk-along and a sit-down on the beautiful Corniche where a variety of ethnicities can be observed enjoying a constitutional along the promenade. On our last trip, one middle-aged South Indian looking couple passed and repassed us with the gentleman staring long and hard at us and seemed on the verge of conversation but remained silent. Three days later I was in a local bank and saw the same gentleman behind the manager's desk.

Learning that I needed to change some money he asked for my passport. On reading my name he smiled and asked me if I had served in the Indian Air Force, if so, had I been in command of the air base at Adampur in the late seventies and whether there had been any other officer with the same name?

I confirmed his first two queries and said that to the best of my knowledge there had been no one else with the same name in my years with the IAF. He then shook my hand and said we had met once before 33 years earlier. His father had been posted at that air base, he himself was then a pupil at the Kendriya Vidyalaya (Central School) and had received a prize from my wife and a hand shake from me on Annual Day. I had to confess that now in my year my own memory was not too reliable but I simply had to admire his recollection linking faces with a name and a single event in the distant past. 'No Sir' he responded, 'not the event but the gift — it was a Parker pen & pencil set'! People!

Air Vice Marshal Cecil Parker (retd.)

25 Years Back

From Vayu Aerospace Review Issue I/1988

Air India results

Air India, which made a record profit of Rs 301.6 million (approximately $25 million) in FY 1986/87, is expected to report a heavy loss for the current year. Provisional figures for April-September 1987 show a loss of Rs 104 million, compared with a budgeted profit of Rs 130 million.

Of the airline's 18 scheduled routes, only five have been showing a profit. Whilst the number of passengers transported showed an increase of no less than 15.5%, revenues dropped by about 6%, indicting a substantial drop in yield.

Additional A320s for I.A.

Indian Airlines, which expects the delivery of 19 Airbus A320s during the 11 months ending April 1989, may now also purchase 12 more to meet needs of the ever-increasing flow of traffic.

The agreement to buy 19 aircraft provides for the training of 152 pilots by Aeroformation, Toulouse, an Airbus sister company. The new fleet would need a large number of type-certificated pilots. Currently the airline employs about 465 pilots for its fleet of 52 aircraft, including those on lease. The airline has decided to employ and train more than 200 pilots on its new fleet, taking the total to about 700.

Of the total fleet of 52 aircraft, ten turboprop aircraft would be phased out in 1988.

Watchman Radars

Plessy has won its first order from the Indian MoD for a Watchman radar system, a significant market breakthrough as India is the ninth country to buy Watchman. An important factor in the award of the contract, secured against strong international and local competition, was the offer of a particularly short delivery of only four months.

This will be used by the Defence Research and Development Organisation (DRDO) for surveillance of air and sea targets at a test range in India.

France orders more Mirage 2000s

The French Government has signed a new order for 35 additional Mirage 2000 combat aircraft, as part of the "military programmes law", which is a multi-year procurement, research and development programme. The new order includes the Mirage 2000DA air superiority configuration, which was first put out in operational service in July 1984, and the Mirage 2000N nuclear armed, low-altitude penetration configuration.

Mirages for Iraq

The Iraqi Air Force is finalising a contract for follow-on batch of Mirage F.1 fighters comprising 12 aircraft. It has been anticipated that the Iraqi Air Force has been seeking additional Mirage F.1s for some time to make up combat attrition, Iraq has received a total of 113 Mirage F.1s since 1980, the last of these being delivered in 1987.

HAL delivers Phase VII Jaguars

First of the Phase VII Jaguars representing the final indigenous-standard aircraft to be built under licence by Hindustan Aeronautics Limited at their Bangalore complex, was formally handed over to the Indian Air Force by the Defence Minister on 20 January 1988. The Jaguar, christened as the 'Shamsheer' was officially accepted by Chief Marshal Denis La Fontaine during a ceremony at HAL's Aircraft Division, Bangalore, the aircraft itself having earlier been handed over to the Minister by the Chairman of HAL, Air Marshal (Retd) MS Wollen and Managing Director of HAL's Bangalore Complex, Wg Cdr (Retd) Inder Chopra.

It is expected that a further batch of 15 Jaguars will be ordered on HAL, taking the total supplied/produced to over 130. Jaguars now provide the IAF with its frontline strike force, equipping four squadrons while a fifth unit has just received the Jaguar-Maritime version. Integrated with a Thomson-CSF/Dassault Agave multimode fire control radar in a aerodynamically-streamlined radome, the Jaguar-Maritimes will be equipped with the new generation BAe Sea Eagle anti-ship missile.

400th Aerospatiale Dauphin

The 400th Aerospatiale Dauphin was handed over at Marignane on 30 November 1987, marking the delivery of 27 SA 365Ns to Pawan Hans Ltd (PHL) in India. PHL, previously known as the Helicopter Corporation of India, has now received 21 Dauphin 2s for offshore work on behalf of the Oil and Natural Gas Commission and six for VIP transportation. Some 95 per cent of Dauphin production to date has been for export, to 89 customers in 42 countries.

Sadaa Mars !

There are disquieting reports that Punjab, the granary of India, is unable to meet the country's food requirement as cultivable land is diminishing.

'Apna Maruta' (NASA's Curiosity Rover on Mars)

Here is an option : SpaceX founder Elon Musk has announced detailed plans to send 80,000 people to colonise Mars by ferrying explorers to the Red Planet for $500,000 per trip. Those from the Punjab could well become the first families on Mars and they "would start a self-sustaining civilisation and blossom this into something really big". With the help of carbon dioxide, Martian soil would be capable of growing crops for food. Equipment carried over could also produce fertilisers, methane and oxygen using the atmosphere's natural elements of nitrogen, carbon dioxide and its surface of ice water.

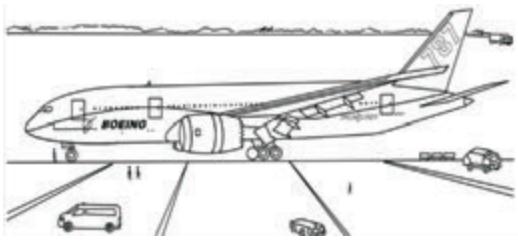
The Punjabi farmer has always been successful wherever he goes. Here is an out-of-the-world opportunity !

Me first!

It seems that every captain in Air India is vying to fly the premium 'Dreamliner'. Erstwhile AI pilots (who fly international routes) had earlier struck work when the company decided to distribute Dreamliner training slots between them and erstwhile Indian Airlines (IA) pilots.

Commanders, based on seniority, from both AI and IA, are being sent for training on the Dreamliners. However, in December, eight simulator slots in Singapore meant for training IA pilots had to be cancelled as the airline was unable to spare pilots. Executive pilots (those who hold managerial posts) belonging to IA - and who are the senior most in the cadre and first in line to be trained on Dreamliner - are resisting the proposal. "Seniority is sacrosanct in any airline," an executive pilot said.

As is the Dream !



Colour me Green – for Envy

We are older than you thought

The beginnings of India's history has been pushed back by more than 2,000 years, making it older than that of Egypt and Babylon. Latest research has put the date of the origin of the Indus

A Mohenjo-daro seal

Valley Civilisation at 6,000 years before Christ, which contests the current theory that the settlements around the Indus began around 3750 BC. Ever since the excavations at Harappa and Mohenjo-daro in the early 1920s, this civilisation was considered almost as old as those of Egypt and Mesopotamia. The finding was announced at the 'International Conference on Harappan Archaeology', recently organised by the Archaeological Survey of India (ASI) in Chandigarh.

In December 2012, three Squadrons of the Indian Air Force marked the 70th anniversary of their foundations, No.14 Squadron's crest could well have been 'inspired' by the Mohenjo-daro bull. Some lineage !

Crest of No.14 Squadron, IAF

'Tejas' being milk fed

For those following travails of the light combat aircraft, which was named Tejas ('Brilliance') many years back, there is hope yet ! But this is not the Tejas of high flight but a cuddly leopard cub at the Delhi Zoo which was brought there for rearing by a family from a UP village. For months, Tejas was fed milk by the family but now that he can no longer be petted, with jaws strong enough to tear into raw flesh, the zoo has taken over.

What should ADA / HAL feed the Tejas LCA so that it too can grow into a formidable combat aircraft for the Indian Air Force ?

Suggestions to 'Talespin'
c/o *Vayu Aerospace Review*.

Afterburner

BOEING

Shinmaywa