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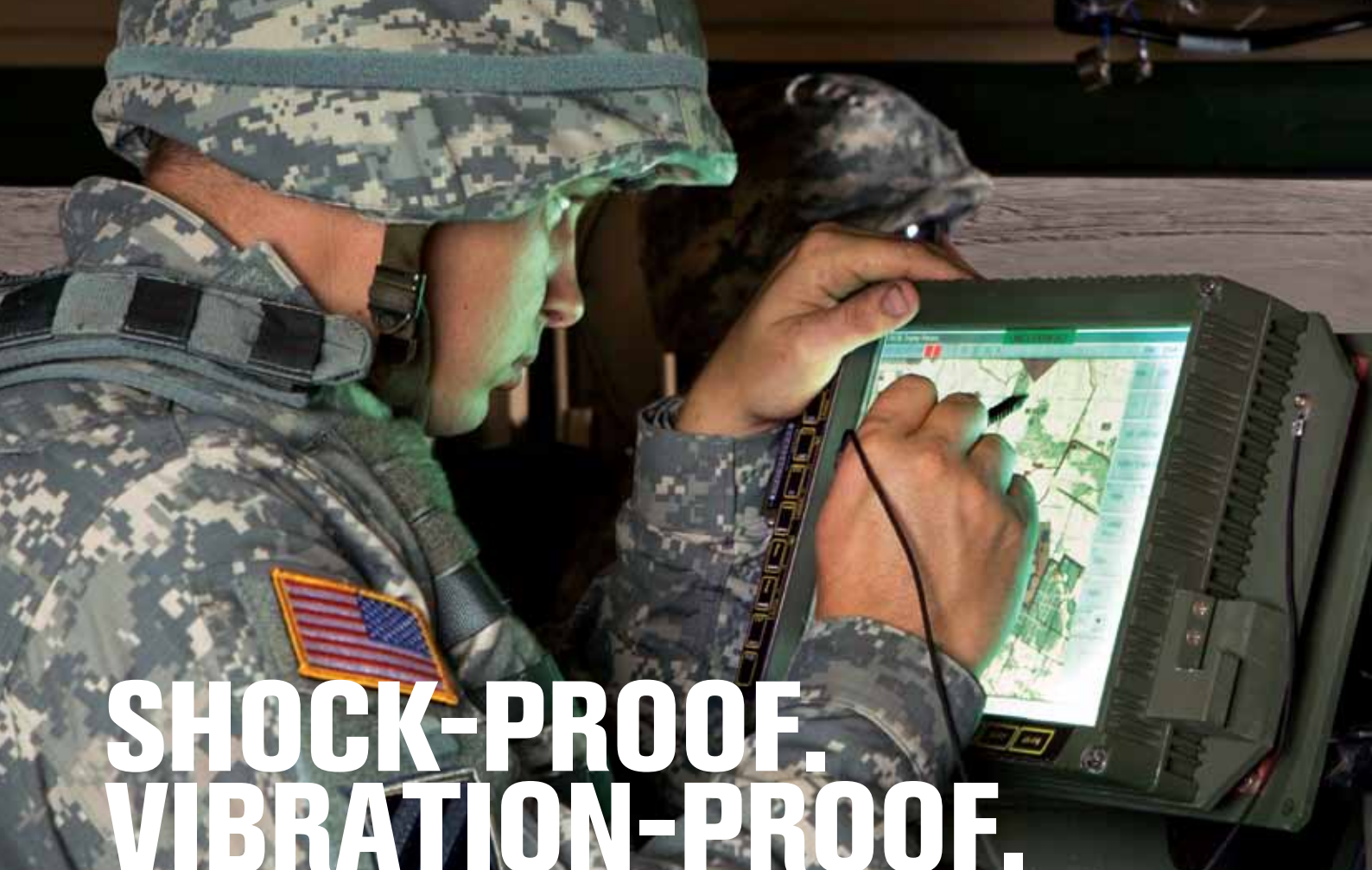

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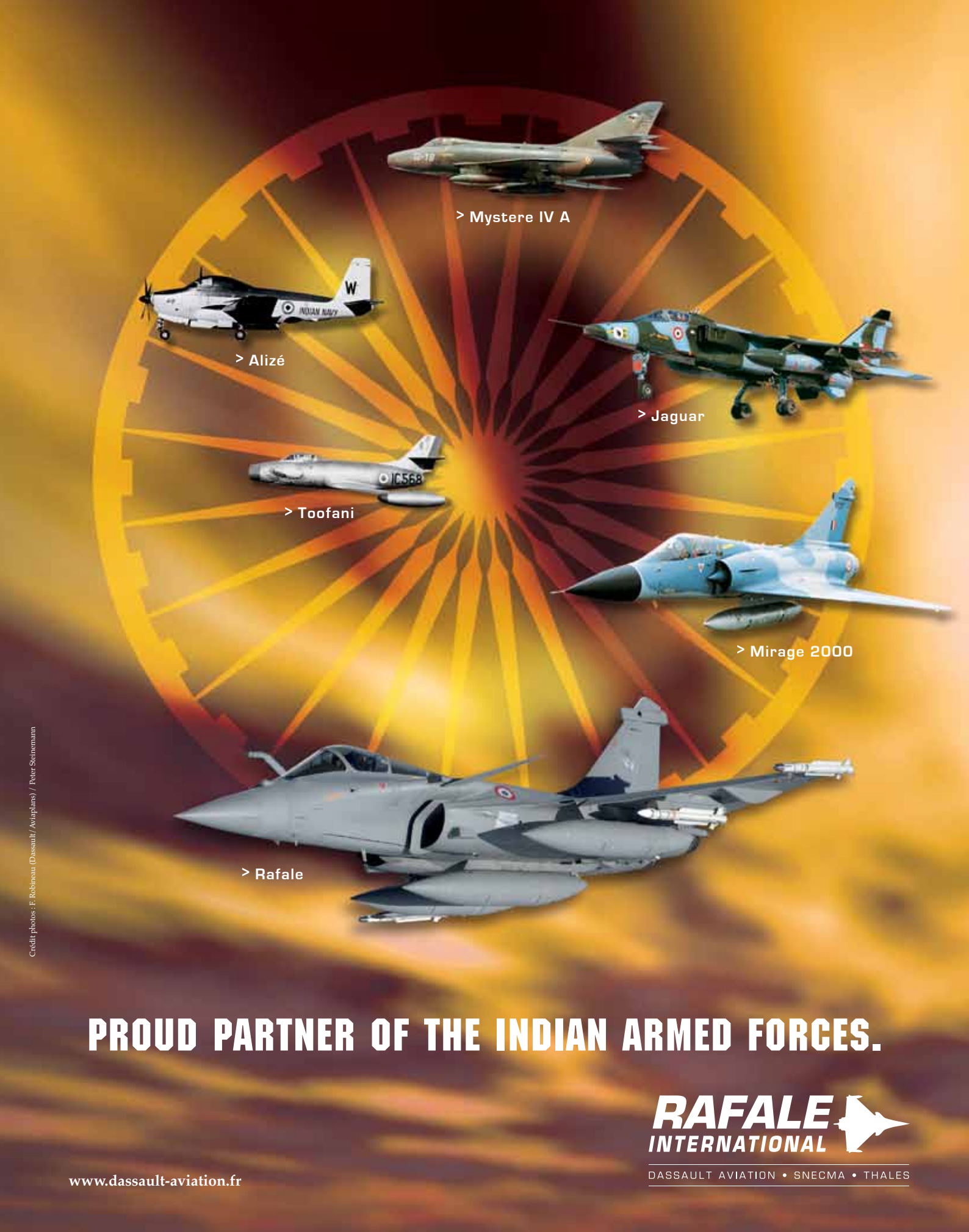

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Content

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Perfect Symphony:
An F-22 Raptor sits on the flightline

COVER PHOTOGRAPH: A US AIR FORCE F-22 RAPTOR EXECUTES A SUPERSONIC FLYBY

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Eight and ever exciting, Aero India this year hopefully echoes the metamorphic change of an economically resurgent Asia and the Indian subcontinent. The upsurge in the Indian defence spending continues unabated with the Indian Air Force (IAF) leading from the front. Be it the massive $80 billion (₹3,60,000 crore) for its fighter aircraft programmes or tens of billions of dollars for each of its programmes for helicopters, transports, weapon systems or force-multipliers et al, there is a huge market potential for the foreign vendors, as well as domestic suppliers—public and private.

With a track record of seven successful air shows, Aero India is fast moving to don the mantle as the third largest air show in the world—after Farnborough and Paris Air Show—bringing together players in the global aerospace industry, big and small, to showcase their products and capabilities and to explore new opportunities for collaboration. February 9 to 13 holds promise of unravelling many significant and far-reaching deals and memoranda of understanding for the Indian defence establishment. With an overall market potential running into over $100 billion (₹4,50,000) in the next 10 years, cynosure of defence manufacturers across the globe, India plays host to more than 600 companies showcasing their products and services. At the forefront would be companies from the US and the UK, Russia, France, Germany, Israel, Italy, Australia—to name a few. Led by none other than the ubiquitous Hindustan Aeronautics Limited, there is likely to be an upsurge in the Indian companies as well. One is likely to see the latest in military and civil aircraft, weapons and related equipment/systems and UAVs.

For us at SP Guide Publications, as the official media partner of Aero India 2011, it is a matter of great pride to be associated with an aerospace event of this magnitude. The entire SP Guide team heartily congratulates the event organisers for their immense effort to make this show a resounding success and an unforgettable experience.

Let the curtain be raised!

Jayant Baranwal
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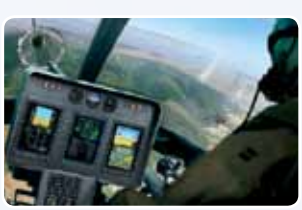

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Looking at 2012 and Beyond

On worldwide markets, the forecast pinpoints how Asian economies such as China and India have become major drivers of business jets as the economies are booming and the number of high net worth individuals who can afford to buy business jets is on the rise

By R. Chandrakanth

Enormous Potential: Bombardier Global 5000

PHOTOGRAPHS: ABHISHEK / SP GUIDE PUBNS & CESSNA

Torpid recovery, notwithstanding, business jet manufacturers are looking ahead with prospects of large-cabin planes setting the pace. Industry forecast is that by 2012, the demand for new jets will improve, stemming from global recovery and deferred demand, thus ruling out any sharp recovery in deliveries.

Honeywell has pegged business jet sales at about 11,000 units valued over $225 billion (₹10,12,500 crore) for 2010-20 and about 5,000 jets for 2011-15.

"This year, operators outside North America have become more cautious about the strength and pace of the recovery. While they are still looking beyond the current economic climate and anticipating a return to improved business conditions, they have tempered near-term expectations and buying decisions, as reflected in the cur-

Cessna Citation: 20 of them are now operating in India

rent delivery forecast," said Rob Wilson, President, Business and General Aviation, Honeywell Aerospace.

Medium to large aircraft, combined, account for almost 32 per cent of the projected demand through 2015. Light and light-medium aircraft make up about 22 per cent of the projected five-year demand. The next largest groupings are in long-range and ultra-long-range aircraft at 21 per cent. On worldwide markets, the forecast pinpoints how Asian economies such as China and India have become major drivers of business jets as the economies are booming and the number of high net worth individuals (HNWI) who can afford to buy business jets is on the rise. Similarly, the Middle East market is a high growth market for business aviation.

Indian Scenario

The Indian Government has reported that the economy has been growing at 8.9 per cent for two consecutive quarters in the current financial year that ends in March. India sustains a six per cent growth rate for 50 years and it is expected to equal or overtake China in that time. A perfect clime for business aviation to prosper. At present, the number of private aircraft in India is over 550 (about 100 business jets), including nearly 300 helicopters and the projections by Business Aviation Association for India (BAAI) is 1,400 in the next five years.

Cessna

The most promising statement has been that of Trevor Esling, Vice President, International Sales, Cessna Aircraft Company who forecasts, "By 2025, I would expect India to be in the top 10 individual countries for business jet ownership outside the US.

"There are currently 20 Cessna Citation aircraft operating in India, part of a total fleet of around 100 business jets right now. I would expect to see a total business jet fleet of 200-250 aircraft in India in 10 years' time," he added.

India is important to Cessna and the expanding economy should soon support a robust business aircraft fleet and infrastructure. The Indian market has readily accepted both the Citation CJ2+ and the Citation XLS+ as particularly strong aircraft for the subcontinent, alongside the Citation Sovereign. These aircraft offer excellent short-field capability in hot climates and non-stop capability anywhere within India, so are well-suited to the market.

There are nonetheless bureaucratic and regulatory issues that are not very favourable for the business jet market in India, such as high import taxes and the difficulty of transferring money into and out of the country. These issues are certainly inhibitors to the fast acquisition of aircraft. Furthermore, the limited business aviation infrastructure is currently an impediment to the development of the Indian business jet market.

Bombardier

The Canadian aerospace major Bombardier offers three families of high performance business jets—Learjet, Challenger and Global. Bombardier will soon offer clean-sheet replacements for the Global Express XRS and Challenger 605, for entry into service in 2015 and 2016. Bombardier is estimating additional 350 business jets entering the Indian market by 2019.

With business jet penetration still very low in India, Bombardier sees enormous potential. Currently, India's business aviation sector is not living to its full potential due to a lack of aviation infrastructure, stringent government regulations, long procedures for aircraft imports and strict bank regulations. The Indian business jet fleet is expected to grow at a compound annual growth rate (CAGR) of 13 per cent over the next 10 years, and to account for 440 aircraft in 2019, the company has said.

Dassault Falcon 900: Coming to India in two years

Bombardier is also hoping that the new all-composite Learjet 85 which is to hit the skies in 2013 will dominate in the mid-size cabin segment.

Falcon

Since the rollout of the first Falcon 20 in 1963, 2000 Falcon jets have been delivered to 67 countries worldwide. The family of Falcon jets currently in production includes the tri-jets—the Falcon 900EX EASy, 900LX, and the 7X—as well as the twin-engine Falcon 2000LX.

The International Sales Director Thierry de Poncins said, "In the last few years, Dassault has invested heavily to increase its footprint in Asia. We opened a new office in Beijing last year (2010) in addition to our existing sales offices in Hong Kong and Kuala Lumpur. We have been in India for a long time and we have been successful, when you consider our market share which is over 60 per cent in the large cabin segment.

"Till date, the best performing aircraft has been the Falcon 2000 series, because of its exceptional flexibility and low operating cost. A Falcon 2000 can fly you from South to North India non-stop, in a large and comfortable cabin. At the top of our range, the Falcon 7X was certified in India last year (2010) and is becoming more attractive in India. We have already sold six Falcon 7Xs in India; the first was delivered in early 2010 and we will deliver the other five—along with 10 more Falcon aircraft (Falcon 900s and 2000s)—within the next two years," he added.

"We are continuing to increase our efforts locally to ensure our operators continue to benefit from cost-efficient and reliable operations, with the optimum support and response," he said.

"Our aircraft are also very cost-effective to run as they use up to 40 per cent less fuel than other aircraft in the same category, even with three engines (such as the Falcon 900LX and 7X). This is very important in India, as operators and owners are focused on operating costs. It also means lower gas emissions— another important factor in a market which is very concerned about environmental issues," he said.

Embraer

India represents till date about 40 per cent of the Brazilian manufacturer, Embraer's executive jets sales in Asia. "Embraer has special links with India," stated Jose Eduardo Gandara Costas, Vice President, Sales and Marketing, Asia Pacific, Embraer Executive Jets, and added, "All Embraer products are present in India and the country has given Embraer a lot of confidence and because we truly believe we have the right products to offer to our customers in India."

Embraer has the vision to become one of the market leaders in executive aviation by 2015. It has consistently launched new products since the Legacy 600 super mid-size jet entry into service in 2002. It launched the Phenom 100 and the Phenom 300 jets in 2005 (entry level jet and light jet, respectively), the Lineage 1000 Ultra Large Jet in 2006 and the Legacy 450 and 500 jets (mid-light and mid-size categories, respectively) in 2008.

With a strong presence in the Indian market, Embraer has placed products with both national government agencies and private companies. Key customers in India who operate the Phenom 100 include Aviators India Pvt. Ltd and Invision Pvt. Ltd. The latter received the first two Phenom 100s in India, which are part of a total order for 18 Phenom 100s and two Phenom 300s. The Indian Government currently operates five Legacy 600 jets—four by the Indian Air Force and another by the Border Security Force (BSF).

Gulfstream

Gulfstream, the business-jet making unit of General Dynamics Corporation, is in an expansion mode. Jason Akovenko,

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Regional Vice President, Asia-Pacific, said that "the growth of private aviation in India reflects a worldwide trend. In 2010, more than 60 per cent of the orders for Gulfstream aircraft were from customers outside North America, compared to 51 per cent in 2007. This shift in the market make-up ideally positions India, an emerging economy, for growth. The influx of business from countries already known for their use of business aircraft will further spur this trend."

Embraer-135BJ Legacy: India represents 40 per cent of Embraer's jet sale in Asia

Bombardier Challenger 300: According to company estimate, 350 business jets would be sold in India

Gulfstream's fleet in Asia-Pacific has grown dramatically over the past decade. In India, the number of Gulfstream aircraft has grown from five aircraft in 2001 to nearly 20 in 2011. Aero India provides an opportunity for our customers to learn more about the advanced technology, superior craftsmanship and outstanding performance of Gulfstream's aircraft.

The growing fleet of Gulfstream jets in the Indian skies will soon include the all-new and much-anticipated G650—the largest, fastest, longest-range purpose-built business jet. The Mach 0.925 G650 is due for the Federal Aviation Administration (FAA) certification in 2011 and entry into service in 2012. The aircraft will have a range of 7,000 nautical miles, connecting Mumbai or New Delhi to London non-stop at a very high speed. Alternatively, it will link any two cities across the globe with a maximum of one stop. Gulfstream has a 200-order backlog for the G650, its new flagship aircraft.

Seventeen Gulfstream aircraft are in the Indian fleet, all of them in the mid- to large-cabin segments, making them among the most capable private aircraft in India. Companies and individuals will need to fly farther as business expands among continents, providing an incentive to trade up to larger Gulfstream models or acquire Gulfstream aircraft for the first time.

Hawker Beechcraft

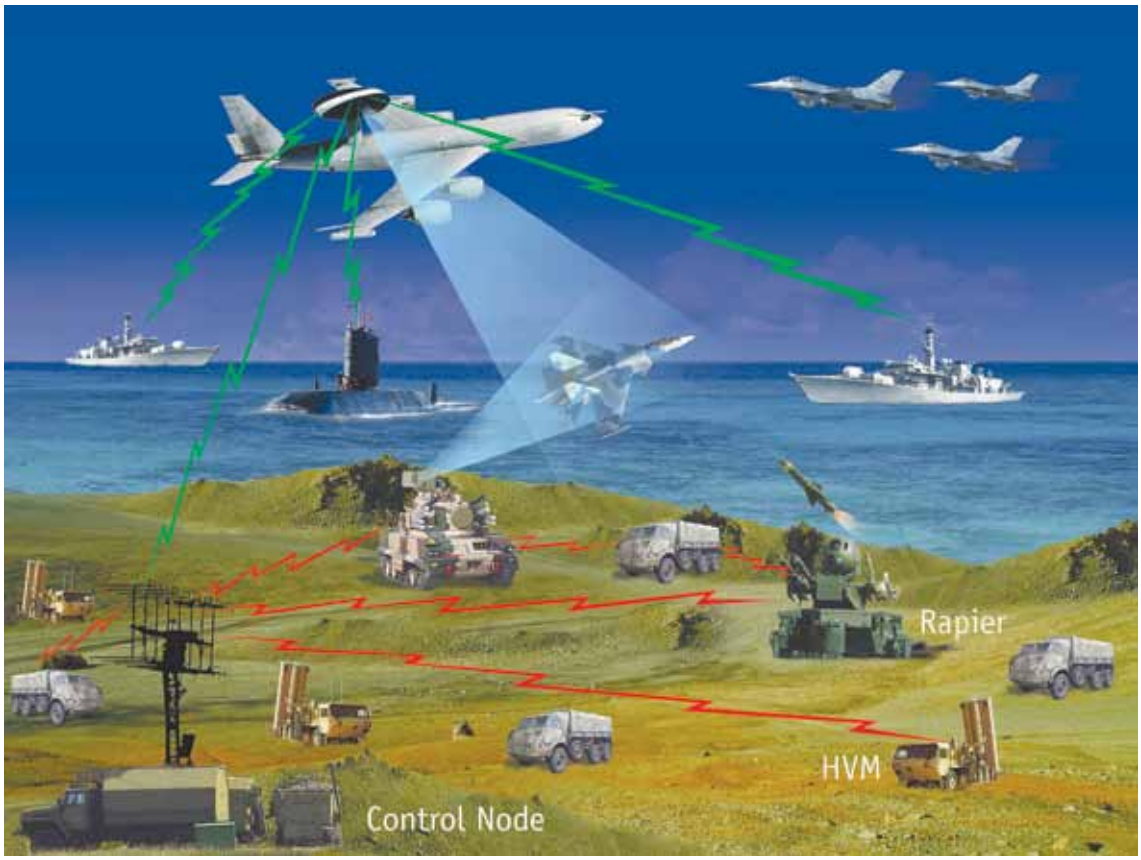
Over the next five years, Hawker Beechcraft expects sales growth outside North America to continue to outpace sales growth within North America. As an example, 10 years ago, the US market accounted for more than 70 per cent of new sales. Accordingly, the company is devoting additional resources to capture such growth.

"We are seeing growth potential in emerging markets including Africa, Asia, China, India, Middle East, Russia and South America," said Sean McGeough, president, Hawker Beechcraft Europe, Middle East and Africa. "Overall, the drivers of demand for new aircraft purchases are slowly returning to pre-financial crisis levels, and the demand is currently stronger in these emerging markets than in North America and Europe."

The installed base of aircraft in Russia, Middle East, Africa and Latin America is between 20 and 25 per cent of the installed base in the US. In Asia, the corresponding figure is just six per cent.

"There are a number of reasons for this variation around the world, including the availability of financing tools, customer service issues and a lack of parts supply programmes," said McGeough. "We see many of these issues as an opportunity for Hawker Beechcraft. With increased globalisation and regulatory liberalisation, barriers to growth in these markets are falling," he added.

Hawker Beechcraft is beginning to see stabilisation in key market indicators and is cautiously optimistic that market recovery will begin in 2012. ■



Net-Centric Lends the Edge

Powerful information processing and communication systems have resulted in dramatic improvements in the quality and quantity of information available to the defence forces

By Lt General (Retd) Vijay Oberoi

Major changes are taking place in the security environment of India as well as in the region of its interest. Warfare is also changing, with the Revolution in Military Affairs (RMA) impacting on it. Coupled with this is India's increasing vulnerability to non-state actors, sponsored by inimical states. There are internal challenges, too, which are likely to multiply in the coming decades. There is considerable thought in the Indian military about using the latest technology and particularly in using the electro-magnetic spectrum to bring about changes in the defence forces that will enable them to meet future challenges efficiently, so that the military continues to win battles, wars and conflicts for the nation as in the past.

Since World War I, the primary emphasis in military modernisation has been on "platforms"—better aircraft, better ships, better tanks and so on. Today, platforms are considered less important than networks in an electronic web that ties all the weapons together, so that the sum is greater than the parts. The main components of RMA are: command, control, computers and communications, intelligence, surveillance and targeting (C4IST); and the development of doctrine, strategies, tactics and

ILLUSTRATION: SP GUIDE PUBNS

military organisations that can take advantage of this technological potential. C4IST is the heart of network-centric warfare.

Net-centric warfare must always be viewed in the joint context amongst the three services, as well as many other agencies and departments of the government. Fielding a stand-alone net-centric system would be of little value, as the dividends will be marginal. Although we had started on the wrong foot in developing the necessary hardware and software independently, it is believed that the three services now have a fair degree of co-ordination between them.

The defence forces of India understood the need to harness the power of the electro-magnetic spectrum over two decades back and set up a number of task forces to research, evolve, test and field a number of systems. Considerable work has been done to develop various battlefield systems during these years. However, for a number of reasons only a few stand-alone systems have been fielded. In this respect we are lagging behind most western nations, as well as Russia and China. The reasons are many, including fiscal, cultural and historical aspects, but I am of the firm view that the prolonged and high degree of preoccupation with internal challenges has shifted the focus of at least the Indian Army, resulting in neglect of other aspects.

Importance of Harnessing Information

Information superiority, like air superiority, is a necessary condition for the conduct of successful operations. Information superiority is created when one side is able to establish a superior information position vis-à-vis an adversary. The relationship between information and combat is well known. However, the challenge has always been as to how it can be maximised.

Physical and Mental Domains: All military operations are conducted in three domains. Two of these, the physical and the mental, are well known and understood. The physical domain is where attack, defence and manoeuvre occur. Elements of this domain are easy to measure, namely, lethality and survivability. The domain of the mind is where battles are won and lost. This is the domain of the intangibles: leadership, morale, unit cohesion, level of training and experience, public opinion and so on. Key attributes of these intangibles have remained relatively constant.

The Information Domain: The third domain is that of information. It is this domain which is now increasing combat power exponentially. It is network-centric forces which help us to share a common operational picture, resulting in a very high level of shared situational awareness. Protagonists of network-centric warfare assert that there is a strong correlation between information sharing, improved situational awareness and significantly increased combat power. It is also true that network-centric operations impact at all levels of war: strategic, operational art and tactical.

Hierarchy Versus Networking

Hierarchy is not yet dead, but in a network environment it will be under pressure to change. The Indian defence forces currently conform to an organisational philosophy of vertically integrated command and control. This organisational system reduces uncertainty by providing a framework that specifies how individuals, sub-units and units should behave, as well as their relationship to others. In a hierarchy, people reduce their uncertainty about why to act and what to do by reducing all the available information to only that which they need in order to perform a task at their level and in their specialisation.

On the other hand, transition to a network-centric force requires an organisational system that increases the productive capacity of the subordinates by maximising individual and variable human intellectual effort.

Capabilities of Net-centric Forces

A network-centric force has the capability to share and exchange information among geographically dispersed elements, whether they are sensors, shooters, decision-makers or supporting organisations. In other words, it is an aggregation of existing and emerging concepts and technologies, in terms of linking sensors, weapon systems and command support elements, to achieve a more coordinated approach to decision-making in combat. This results in a common operational picture and a common tactical picture. Network-centric forces synchronise their efforts from the bottom-up, to achieve dramatically increased combat power. The ability to increase combat power at the tactical level provides operational commanders with increased flexibility to employ their forces, to generate desired effects. Network-centric warfare thus provides commanders with an improved capability for dictating the sequence of battle and the nature of engagements, controlling force ratios and rapidly foreclosing enemy's courses of action.

Limitations of Net-centric Forces

On account of the impact of technology, operations are shifting from being linear to being dynamic and multidirectional. Units and formations would need to be task-oriented and should have the ability to move freely on the battlefield. Data acquisition, transmission, processing and display will have to be quick, without interruption between the different media employed. While networking will deliver a range of benefits, it needs to be noted that collaborative decision-making via networks may cause information overload, command gridlocks and even a degree of chaos in operations.

In some respects, networked technologies may amplify uncertainty. While technology can deliver a greater quantity of accurate data, the decision loop involved might be so radically shortened that response time may be reduced to a bare minimum. While a soldier will draw on an array of battlefield assets,

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he is likely to be increasingly disassociated from the results of his decentralised decision-making. Networks are complex systems that, unlike hierarchies, thrive on connectivity, flattened command structures and 'peer-to-peer' nodes of communications. In cases where there is a long chain of command dependency, small failures can slow down decisions. As network complexity increases, solutions to problems in one node are likely to require parallel adjustments to behaviour in other nodes.

Joint Service Focus

All the three services have been developing a range of networking capabilities but usually with an environmental rather than a holistic or joint focus. Single services tend to design their future operations around existing forces, with an overlay of network improvements, based on today's knowledge. It needs to be remembered that future networks may create an operational environment that cannot be anticipated or predetermined. The professional military inclination is to seek to control change and try to plan, to the last detail, while evolving a networked force. Yet, we need to be prepared for unpredictable features. Consequently, while evolving the networking plan, we should seek general direction, but we must possess the imagination to exploit unforeseen opportunities as they arise.

Network-centric operations must be joint endeavours to the maximum extent. Most operations, whether in the conventional or the subconventional arenas, must be joint or in our context at least bi-service. Therefore, not fielding net-centric capability in a joint manner amounts to diluting our capability. This is an extremely important issue and needs to be reflected upon by the hierarchy of the three services and those involved in developing such capabilities.

Organisational Changes

There are four main ingredients of institutional change: technology, ideas, people and organisation. Networked technologies open access to what is always rare in warfare—information. A fascination with technology alone is counter-productive, as it might lead to a narrow approach towards change. It is necessary to weigh how much decision-making should be devolved to machines. Networking doctrine emphasises the need for a process of constant innovation and identifies two key capabilities. These are, firstly, an ability to produce new ideas, and secondly, organisational effectiveness in turning these ideas into practice. If technology is to be implemented successfully, then even personnel policies would require significant changes. Indeed, effects in the areas of hierarchy, leadership and combat organisation could be far-reaching.

Attitudinal Changes

All new technologies represent a challenge to an existing social order and imply gain for some constituencies and loss for others. There is also an intra-organisational competition for resources and status. Since the results of networked technologies are likely to have major impact on the sociology of military organisations, the greatest challenges that the armed forces will face are likely to be cultural, in the form of introducing changes in thinking and behaviour.

Existing attitudes and beliefs about how warfare is conducted today may well be the biggest impediment in achieving network-centric capabilities. Increase in information sharing has the potential to create dramatic improvements in single service and joint war fighting capabilities. Exploiting this potential will require capabilities in exploring new tactics, techniques and procedures.

Increase in networking is achieved by investing in networks, and by education and training of soldiers who operate the network in operations. Training joint and combined forces that have compatible networking capabilities is important to the development of new tactics, techniques and procedures.

Conclusion

Network-centric warfare is becoming the dominant logic of current and future military operations. These technologies bring with them a dramatic increase in the quantity of information, the need for constant interaction and a demand for greater organisational transparency. These advances have made it possible to detect, identify and track a far greater number of targets over a larger area, for a longer period of time, than ever before.

Powerful information processing and communication systems have resulted in dramatic improvements in the quality and quantity of information available to the defence forces. New technologies have enabled militaries to make the optimum use of the electromagnetic spectrum. This is a continuous process, constantly getting upgraded by new technologies, which are more efficient, robust, are light and occupy less space.

Net-centric capability requires a multidisciplinary and holistic approach, which includes the development of matching doctrine and infrastructure, restructuring and even re-engineering of some organisations. It also requires qualitatively higher knowledge and skill thresholds. There is need to network different sensors, weapons and command and control systems. The armed forces, the entire national security establishment, Defence Research and Development Organisation, PSUs and information technology companies have to work closely in unison and leverage their capabilities, so that a truly Indian system emerges. There is need to take a hard look at all these issues and give impetus to this process through a well thought out plan. ■

The author is a former Vice Chief of Army Staff and former Founder Director of Centre for Land Warfare Studies.

C-27J Spartan: Eyeing the Indian military transport market

NextGen Airlift Capability

Military air transporters are inherently multi-role and the fastest means available to ferry personnel and war material to the area of operations

By Air Marshal (Retd) V.K. Bhatia

Revolution in military technology has made it possible for a combat aircraft (bomber) to attack a target anywhere in the world and return to its home base without having to take recourse to landing at an intermediary base. The US B-1/B-2 bombers showcase such offensive capability. But this capability alone cannot win wars—for that 'boots' are required on the ground. This is where military transport aircraft come to the fore, affording the fastest means available to ferry personnel and war material to the area of operations. Military air transporters are inherently multi-role. The cavernous hold of the aircraft is easily modifiable to undertake multifarious air transportation tasks; be it carrying men and material into combat zone or air-dropping troops and all kinds of cargo into the battle area. These aircraft turn into aerial angels when used for speedy casualty evacuation, act as airborne command posts when required, and even take on the role of mean makeshift bombers for pulverising enemy positions—preparing the ground and making it easier for final assault by ground troops.

But like the Mach-2, afterburning, super-cruising, variable-thrust, with stealth and ultimate manoeuvrability fifth generation fighters—the everlasting toast of the military aviation fraternity, can the evolving military transport aircraft be also classified as the fifth generation transports? Perhaps not. But the transport aircraft designs are certainly evolving into 'NextGen', the mantra being the capability to deliver their payloads at the very doorstep of operational locations

PHOTOGRAPHS: ABHISHEK / SP GUIDE PUBNS

irrespective of their size, range or payload capabilities. It is this trend that has taken the centre stage of design parameters in all the military transport aircraft launched recently or under development.

Clubbed into three main categories, military aircraft come in different sizes and shapes to perform their basic roles as strategic, tactical, and strategic/tactical roles. Strategic airlift involves transportation of material, weaponry or personnel over long inter-theatre or inter-continental distances. How are the contemporary designs evolving in the three categories?

The Heavies

Boeing C-17 Globemaster III: Take the case of the Boeing C-17 Globemaster III, which is so ably supporting the US' Global War on Terror. The C-17 has been designed for strategic airlift of troops and cargo to not only the main operating bases, but also forward operating bases throughout the world. It has the ability to rapidly deploy a combat unit to a potential battle area and sustain it with regular supplies. The C-17 is also capable of performing tactical airlift, medical evacuation and airdrop missions. The C-17 is designed to operate from runways as short as 3,500 ft and as narrow as 90 ft. In addition, the aircraft can operate out of unpaved and unimproved runways. For cargo operations, this massive aircraft with a maximum payload capacity of 77 tonnes needs a crew of just three (pilot, co-pilot and loadmaster). So impressed has the IAF been with the C-17 that it is going ahead with a $5 billion (₹22,500 crore) 10 aircraft deal with the US through the FMS route with a future option for six or seven more.

Turboprop Variants

A400M/An-70: Other latest aircraft such as the European Airbus A400M and the Ukraine/Russia An-70, though differing considerably in design (especially in the use of power plants) are striving for similar off-field capabilities. The A400M 'Grizzly' that successfully completed its maiden flight on December 11, 2009, and well into the flight testing programme now, has wings primarily made of carbon fibre reinforced plastic. The aircraft is powered by four Europrop TP400-D6 engines rated at 8,250 kW each which make them the second most powerful turboprop engines ever produced, next only to the D-27 propfans to be fitted on the bigger An-70 airlifter.

Another revolutionary concept showcased by the A400M is that the propellers on each wing of the aircraft turn in opposite directions, with the tips of the propellers advancing towards the midpoint between the two engines. The counter-rotation is achieved by the use of a gearbox fitted to two of the engines. Otherwise, all four engines are identical and turn in the same direction which eliminates the need to have two different handed engines for the same aircraft, thus simplifying maintenance and supply costs. The unique configuration, dubbed as down between engines (DBE), allows the aircraft to produce more lift and

Unique configuration: Airbus A400M:

lessens the torque and prop wash on each wing. It also reduces yaw in a worst-case scenario of an outboard engine failure.

The Middle-weights

Lockheed Martin C-130: The never-say-die Lockheed Martin's Hercules in its new avatar 'Super Hercules' C-130J (-30) still rules the roost in the middle-weight 20-tonne class. Configured for carrying out gruelling 'Special Operations' tasks, the IAF has already started receiving the aircraft out of a total order of six aircraft placed in 2008. There is a great possibility of a repeat order of equal number of aircraft or more at a later date.

Embraer C-390: Brazil's Embraer is another manufacturer which is trying to develop a twin-jet military transport in the 20-tonne category. Once again, design goals include ability to operate from short and unpaved runways without the need for ground support. Use of composites is also being planned with an intended max payload capacity of 19 tonnes.

Indo-Russian MRTA: The much discussed Indo-Russian joint venture to co-develop and co-produce a multi-role transport aircraft (MRTA) in the 20-tonne class was finally formalised in October 2009 during Defence Minister A.K. Antony's visit to Moscow. The twin-engine jet is expected to take to the skies in 2014 with possible induction in 2015. IAF has projected a requirement of 45 aircraft but HAL is likely to lead the design of a 100-seat civil version to be marketed in India and abroad.

The Lighter Siblings

EADS CASA C-295/Alenia C-27J Spartan: In the lighter 10-tonne class are the well established CAS C-295 and the C-27J Spartan which are also vying for a share of the pie in the Indian military transport market. Even the paramilitary forces in India are seriously considering these aircraft to meet their air transportation requirements. ■

Trends in Fighter Development

Categorised into various generations, development is progressing from the past decade's fighters towards what is known as the fifth generation fighters in the current millennium. Read through to know about the characteristics of the latest aircraft and the trends in fighter development.

Fifth Gen:
F-22 Raptor

By Air Marshal (Retd) V.K. Bhatia

More than a century after the first heavier-than-air machine leapt off the ground, the evolution of fighter aircraft has been a saga best described by the die-hard determination and extraordinary imagination of the designers coupled with continuous advancements in technology. Both put together have been responsible for ushering in revolution in military aviation giving the present-day fighters combat capabilities that were unimaginable earlier. From the doddering bi/tri planes of the First World War to the present-day mean machines, the transformation has been fantastic. Categorised into various generations, development is progressing from the past decade's fighters towards what is known as the fifth generation fighters in the current millennium. But what are the characteristics of the latest aircraft and what are the trends in fighter development?

Fifth Generation Fighters

Attributes that characterise the fifth generation of fighter aircraft include highly advanced avionics and stealthy sensory suites, affording the pilot a comprehensive view of the entire battle space. Also characterising the fifth generation is a comprehensive stealthy design and a combination of airframe and engines to provide efficient supersonic speeds i.e. 'supercruise' capability. But that is not all. The fifth generation fighter is aimed to have a 'first look, first shoot and first kill' capability in all conditions of flight and tactical situations. In other words, it must be able to far outstrip its rivals in all departments of aerial combat i.e. detection, identification, acquisition, engagement and destruction. Aircraft that can stand scrutiny in this regard are the Lockheed Martin F-22 Raptor and the not yet operational F-35 joint strike fighter

PHOTOGRAPHS: USAF & MEDIA.MODDB.COM

(JSF), and the Russia-led joint Indo-Russian programme for the development of PAK-FA, fifth generation fighter aircraft (FGFA). However, so far, only the F-22 Raptor has been inducted for operational service with the United States Air Force (USAF). Also, it is the only aircraft considered to have all the attributes of a fifth generation aircraft and merits a somewhat detailed study.

The F-22 Raptor

Designed to be a fifth generation aircraft from the word go, the Raptor incorporates low-observables configuration and construction which has been balanced to give an optimum mix of stealth and agility, unlike in the case of the earlier F-117 that flaunted a stealthy airframe but with little agility. To reduce the radar signature of the aircraft further, antennae have been located in leading or the trailing edges of wings and fins, or flush with surfaces. In addition, all production aircraft have been coated with new Boeing-developed stealthy paint intended to enhance low-visibility attributes. The Raptor is powered by two 156kN (35,000 lb st) class Pratt & Whitney F119-PW-100 advanced technology reheated turbofans, each fitted with a two-dimensional, convergent/divergent thrust vectoring (20 deg up/down in the vertical plane) exhaust nozzle for enhanced performance and manoeuvrability. The powerful engines ensure short take-off and supersonic cruise and manoeuvring (super-cruise) in the region of M 1.5 without afterburning.

The aircraft is equipped with highly integrated avionics for single-pilot operation and rapid reaction. Radar, radar warning receiver (RWR) and communication/identification are managed by a single system presenting only relevant data and the emissions are controlled (passive to fully active) in stages, according to tactical situation. Common integrated processors (CIPs) handle all avionics functions, including self-protection and radio, and automatically reconfigure to compensate for faults and failures.

The heart of the Raptor is its state-of-the-art AN/APG-77 active electronically scanned array (AESA) multi-mode radar, capable of interleaving air-to-air search and multi-target track functions. It also incorporates weather mapping mode with provisions for air-to-ground modes and side arrays. The radar is reported to be capable of detecting 1.2-metre target at a range of approximately 109 nautical miles (201 km). Even this highly capable radar was to be replaced by new AESA radar in 2008 that will eventually incorporate advanced air-to-ground computer software. Fused situational awareness information is displayed to pilot via four colour liquid crystal multifunction displays. Cockpit and instruments illumination is fully night vision goggles (NVG) compatible. The common integrated processors (CIPs) also contain mission software that uses tailorable mission planning data for sensor emitter management and multi-sensor fusion. The CIPs are rated at more than 700 million instructions per second (MIPS) with growth up to 2,000 MIPS and signal processing capacity greater than 20 billion operations per second (Bops) with expansion capability to 50 Bops. One CIP contains more than 300 Mbytes of memory with growth potential to 650 Mbytes. There is plenty of spare capacity in the systems to support future growth. The aircraft has provisions for infrared search and track and side-mounted phased-array radar.

Not yet operational: F-35 joint strike fighter

Raptor has the unique capability to carry all its weapons for its primary air dominance role internally in the fuselage bays in addition to a long-barrel 20mm cannon. Three internal bays can carry two AIM-9M Sidewinder or Next Generation AIM-9X close combat missiles (one in each side bay) and six AIM-120C beyond visual range air-to-air missiles and/or precision-guided GBU-32 joint direct attack munition. It can also carry underwing stores (if stealth is not an overriding factor for a particular mission) on four hard-points capable of carrying 5,000 lb (2,268 kg) each. Other weaponry against surface targets envisaged for use by the Raptor includes the BLU-109 Penetrator, the wind-corrected munitions dispenser (WCMD), AGM-88 HARM anti-radiation missile, GBU-22 Paveway 3 guidance unit for LGBs, new small diameter bomb and the low-cost autonomous attack system submunitions dispenser package. With all the attributes of a fifth generation fighter, the F-22 Raptor is indeed the most formidable combat aircraft ever produced. The synergy that results from combining stealth, speed, information fusion, situational awareness and the ability to operate within and interact with a broad array of networked systems in a single platform represents a quantum jump in capability and survivability over contemporary fighters. The European Eurofighter EF A2000, Typhoon and the French Rafale come pretty close to the Raptor except that they lack stealth and vectored-thrust capabilities—deficiencies which could prove to be crippling in combat scenarios against the Raptor. That is why these, otherwise highly capable aircraft, have fallen short of being called fifth generation fighters.

GenNext Fighters:
China's J-20

F-35, Lightning II

A sibling of F-22 Raptor, F-35 joint strike fighter (JSF) is another fifth generation fighter from the Lockheed Martin design team, whose development is progressing at a feverish tempo. The JSF programme was created in the US to initially replace various aircraft on the inventory of its armed forces. But as of now, eight more nations have joined the programme and many others are waiting in the wings or making up their minds to become partners in the now highly transformed international programme. The JSF is being developed in three variants i.e. F-35A—conventional take-off and landing (CTOL), F-35B—short take-off and vertical landing (STOVL) and the F-35C—carrier variant for conventional, marine and carrier operations, respectively. The improvements over the current fourth or four+ generation fighters include durable, low-maintenance stealth technology; integrated avionics and sensor fusion that combine information from off/on-board sensors to increase the pilot's situational awareness and improve identification and weapon delivery, and to relay information quickly to other command and control (C2) nodes.

The main sensor on board the F-35 is its AN/APG-81 AESA radar designed by Northrop Grumman Electronic Systems. This is augmented by the electro-optical targeting system designed by Lockheed Martin and BAE. Further E-O sensors form part of the AN/AAS-37 system which acts as missile warning system and can aid in navigation and night operations.

Russian Response & Indo-Russian Collaboration

The Russians came up with their own designs in response to the US F-22 Raptor. Finally, Sukhoi was chosen to lead the design for the new combat aircraft called PAK-FA, which stands for 'Prospective Aircraft System of the Frontline Aviation'. To ease its financial concerns, India was invited as 50:50 partners to join the programme. Overcoming its initial hesitation/apprehension, in January 2007, India formally resumed fresh negotiations with Russia over PAK-FA fifth generation fighter development programme which has now been firmed up as a joint collaborative endeavour on a 50:50 partnership.

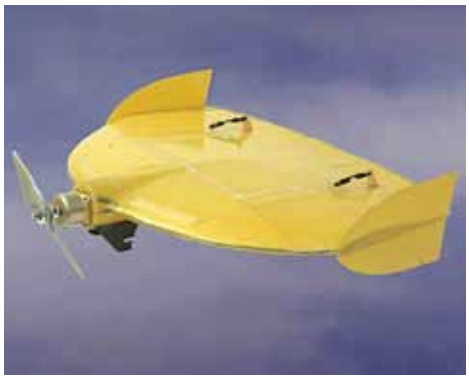
From the reports available, the aircraft will be stealthy, have the ability to supercruise, be outfitted with the next generation air-to-air, air-to-surface and air-to-ship missiles, and incorporate AESA radar. It will be powered by the Saturn AL-41F thrust vectoring engines. It is estimated to be similar in size to the F-22. It is as yet uncertain how low the radar cross section (RCS) of the PAK-FA will be. This will be Russia's first attempt at making a 'stealth' aircraft from a scratch though, all latest production variants of Russian military aircraft use radar-absorbing materials that lower RCS to that of less than 1.2-metre objects.

The Indian version will be somewhat different from the Russian version as it will be customised to Indian requirements. For example, unlike the Russian single-pilot fighter, the Indian variant will also have a twin-seat configuration based on its operational doctrine for combat operations. The prototype took to the air for its first flight in January last year with the development continuing at a healthy pace. The IAF hopes to induct the aircraft into service during the later part of the current decade.

Enter the Dragon

On January 11, the Chinese may have surprised even their own civilian leadership, not to speak of the world at large by launching their own prototype of a futuristic stealth aircraft for a 20-minute first flight. The Chengdu J-20 'Jian er Shi' which literally means annihilator 20 is claimed to be a fifth generation, twin-engine fighter developed by Chengdu Aircraft Industry Group for the Chinese People's Liberation Army Air Force (PLAAF). From the information currently available, the J-20 is a single-seat aircraft which appears to be somewhat larger and heavier than the comparable Sukhoi T-50 (PAK-FA) and Lockheed Martin F-22 Raptor. With an overall length of 75 ft and a wingspan of 45 ft, the aircraft is expected to have a take-off weight of 75,000 to 80,000 pounds with internal stores only. The aircraft may have a lower supercruise speed and less agility than its US and Russian rivals but might have larger internal weapons bay and carry more fuel. The aircraft is likely to be equipped with China's homegrown AESA radar. At present, powered by the Russian AL-31F engines, the Chinese are trying to perfect their own WS-10G engine with a new stealth nozzle for the production series aircraft.

Notwithstanding the West's skepticism and the general impression that the Chinese are at least 15 years behind in building appropriate technologies, with the launch of the 'annihilator', China has certainly become a proud third country in the world after the USA and Russia, capable of producing its own fifth generation stealth fighters. ■



Future Trends:
(Left) Boeing's Phantom Eye,
(Right) IAI's Mosquito,
(Below) BAE Systems Taranis

UAVs of the Future

With current power sources, small UAVs can fly for a few minutes, whereas the requirement is to fly them for hours. Other key UAV challenges are sensor exploitation; navigation and control; cyber issues like jamming, encryption and information falsification by adversaries and communications, because bandwidth and power over long-range are trade-offs.

By Lt General (Retd) V.K. Kapoor

Concepts in the US Army

In the US, the UAV roadmap was discussed on April 15, 2010, at the Army Aviation Association of America conference which released a 140-page document which is meant to help industry understand what the service wants. The roadmap addresses the near term (2010 to 2015), the mid-term (2015 to 2025) and the far term (2025 to 2035). The US Army, it seems would prefer to upgrade its helicopters to perform UAV missions rather than buy expensive new aircraft. The AH-64D Apache Longbow, the CH-47F Chinook and UH-60M Blackhawk already have most of the necessary electronics on board, while Sikorsky plans to autonomously fly the UH-60M by the year end. Now, the Army is doing a cost-benefit analysis for where it wants to introduce unmanned or optionally piloted aircraft. The Army is also moving towards open architectures for its systems and a common ground control station. The roadmap puts a premium on converting existing fleets into unmanned platforms. "Ideally, we will have three switches in the cockpit—zero for unmanned and flying autonomously, one for a single pilot in a two-pilot aircraft and two when there is a co-pilot," says Colonel Chris Carlile, Director, Army's UAS Centre of Excellence.

The US Army helicopter pilots have the ability now to get updated information on targets observed/discerned on the battlefield. Their own sensors will provide this information. In the future, the Army pilot will direct a Predator-like drone to zoom in, right from the air. As it stands right now, the Army's larger drones, like the Grey Eagle—a version of the famous Predator — can send video feeds to Apache helicopters, just as they send video to soldiers below. But currently, Apache pilots can't direct the drones, just receive information passively. This is going to change. Tomorrow's Apache operators "will add command and control" over the Grey Eagles. They will be able to see the im-

PHOTOGRAPHS: BOEING, BAE SYSTEMS, IAI, NG, USAF & DASSAULT-AVIATION

age and control the aircraft from the cockpit of the Apache. The remote sensor and command capability from the Grey Eagles can help an Apache "spot a target," which the armed helicopter can attack itself. That'll come in handy for units like Task Force observe, detect, identify and neutralise (ODIN), the Army surveillance team spying on Afghan insurgents, who fly both drones and helicopters; Special Operations Forces teams that do the same already have their own Grey Eagles.

Future of Mini/Micro UAVs

The greatest constraint and challenge is vehicle propulsion, finding a way to pack more and more onboard power into smaller and smaller batteries. With current power sources, small UAVs can fly for a few minutes, whereas the requirement is to fly them for hours. Other key UAV challenges are sensor exploitation; navigation and control; cyber issues like jamming, encryption and information falsification by adversaries and communications, because bandwidth and power over long-range are trade-offs.

Dr Siva Banda, senior scientist for Control Theory with the US Air Force Research Laboratory (AFRL) Air Vehicles Directorate presented a lecture on the challenges of achieving UAV autonomy at the Naval Postgraduate School on December 2, 2010. He said, "For MAVs (micro air vehicles), a major challenge is achieving controlled stable flight in flapping wing models," and added, "It's hard to make biomimetic MAVs that are highly manoeuvrable like birds and insects within the constraints of hovering, limited power and light weight. This requires the development of highly complex algorithms and miniaturising greater and greater onboard information processing capability." He further stated, "By 2015, the US wants to be able to build bird-size mini UAVs with WMD sensing capabilities and by 2030, a very ambitious goal to have insect-size micro UAVs with WMD sensing, tracking and targeting capabilities that can operate alone or in swarms in contested environments against intelligent adversaries."

Israeli Trends

Several concepts will define Israeli efforts in the unmanned aviation world. Some of the concepts enunciated by Israel Aerospace Industries (IAI) are:

- Cyber and electronic warfare from UAVs is considered a great opportunity. The state of Israel will not be able to ignore the threat and its offensive potential. These digitally-based capabilities will be shaped around what is available in the commercial arena.
- In analysing customer needs for UAVs, IAI leaders state that quantity is seen as the primary consideration. The goal will be low-cost designs that can support each other. They will not be identical and will take on many different tasks. There are to be both master and slave versions of these unmanned aerial systems (UAS).
- Active electronically scanned array (AESA) sensors will be essential for unmanned platforms. IAI has been developing the technology since it was built into the skin of the futuristic IAI Lavi fighter of the 1980s. UAVs are considered natural for AESA and its ability to find small targets and differentiate them.
- IAI is actively working on several new UAV platforms. Some are similar to what is already in service, but they will be cheaper, lighter and invisible. Stealth is an important facet. If it is not too expensive, hundreds or thousands of UAVs could be sent until the enemy runs out of missiles.

Yair Shamir, chairman of the Board for Israel Aerospace Industries says that other possibilities include the bottom of the performance spectrum. Shamir says that during a speech to a small crowd, he launched a six-inch butterfly-like UAV with four, flapping, transparent wings, but with enough stability to take a live video of the observers with a camera on the small craft.

There are additional trends that Elbit has identified.

- There is no need for jet engines. Endurance and low loiter speed is more important.
- In a few years, 40 per cent of the air missions will be conducted by UAS.
- Taking out the pilot means less operator training, fewer countermeasures and elimination of air crew losses. That lowers UAS costs by 5-10 per cent of an F-16.
- Greater number of UAVs can be sent on a mission without much risk. Countermeasures (to protect a manned aircraft) cost billions. With UAVs, we can take risks.
- Moving beyond the boardroom, what do Israeli operators—with more operational experience than almost any other nation—want in next generation UAVs? "I think the next generation of combat aircraft will be UAVs conducting all of the missions done today by jet fighters," says Tomer Koriat, UAV deputy programme manager for Malat's UAV operator training course.
- However, an active duty UAS pilot involved in intelligence, surveillance and reconnaissance (ISR) missions is less enamoured of high performance designs for his work. "We looked at

What's in Future: Northrop Grumman's X-47B UCAS

What's in Future:
X-45A (Top),
Dassault Aviation's nEUROn

whether there was interest in a jet UAV," says an Israeli Air Force captain. "What we find was a primary interest in a platform with long endurance and minimum indicated airspeed over a given area. We don't need the ability to get to someplace quickly. We saw in the second Lebanon War that you need to cover a big area for a long time and to make sure that you can gather all the information needed by the combat commanders."

• Israeli operators feel that the UAVs have to work with an environment that can change from irregular war to full-up, conventional operations at short notice. Hence, the UAV must remain flexible and relevant to all types of operations and terrain conditions.

Some Next Generation UAVs

X-45

Manufactured by Boeing, the X-45 was one of the first of a new generation of UAVs ordered by the Pentagon. Like many of the other planes on this list, it borrows its stealthy, flying-wing shape from the B-2 stealth bomber. Also, based on a grainy photo taken at Kandahar Airbase in Afghanistan, the X-45 may have already seen some action.

X-47

Northrop Grumman's next generation UAV, the X-47, will do for the US Navy what the X-45 may already do for the US Air Force. As a result, the X-47 will be able to take off and land from an aircraft carrier.

Taranis

The British defence firm BAE Systems introduced its new, next-gen UAV in July 2010. Named Taranis, after the Celtic God of Thunder, BAE hopes that advanced computers will allow this drone to perform its mission with less human input than ever before.

Phantom Eye

Unveiled by Boeing in July 2010, the Phantom Eye greens up the sky by running on hydrogen fuel. The Phantom Eye would be a dedicated sky plan, staying aloft for days on end while its complex surveillance package monitors the ground below. With a 150-foot wingspan, the Phantom Eye is one of the largest UAVs ever produced.

nEUROn

Continental Europe's entry into the advanced UAV market, the nEUROn looks a lot like the other next-gen drones in our countdown. Produced primarily by the French company Dassault Aviation with help from seven other European aerospace and defence companies, the nEUROn is more of a test bed for future UAV concepts than a plane slated for impending combat.

Novel Air Concept

This drone is so new that they haven't even started building it yet. Rather, the Novel Air Capability is a speculative future UAV under development in Britain. The project, lead by BAE Systems, hopes to produce an advanced drone capable of vertical take-off and landing, like a helicopter, but straight flight like a plane.

Israel's Panther Tilt Rotor UAV

Israel's new Panther vertical takeoff and landing unmanned tilt-rotor aircraft is one of the latest products emerging from the classified projects section of Israel Aerospace Industries. The UAV was developed by IAI's Malat Division, which has been looking at new designs to fill some of the operational gaps between the company's largest, longest-range Heron TP UAV—now in operation with the Israeli Air Force—and its smallest 0.5-kg (1.1-lb.) mosquito UAV with a 30-40 minutes flight time. The principal features of the aircraft are tilt-rotor engines that allow pinpoint takeoffs and landings or if desired, conventional landing and takeoff operations. It also has automatic navigation to targets of interest and day/night cameras. An intriguing option is the Panther's ability to hover or land quietly in enemy territory, conduct surveillance like a ground sensor and then take off again. It also could be operated from ships that need a tactical UAV. ■

Perfect Solution for Indian Airports

When cost-effectiveness puts high demands on airport operations, Saab's Remote Tower concept could be exactly what small- and medium-sized airports need in order to be competitive. The concept aims at remotely controlling several airports from a single Remote Tower Centre.

Saab, the world leader in remote towers, has developed a technical solution for operating several airports from a single remote tower centre.

An expanding market of commercial aviation, like in India, is not only about more aircraft, passengers, pilots and ground crew. It is also a matter of an effective infrastructure with airports and not to forget, a safe and effective management system of the air traffic control (ATC).

To have a sufficient number of educated and well trained personnel to operate in the ATC systems is a demanding task. It takes years to train an air traffic controller to the high level of skill that matches the very high operational needs.

PHOTOGRAPH: SAAB - PETER KARLSSON SVARTELD

breakthrough concept: Remote operated tower

"The cost of running small- and medium-sized airports consists largely of personnel costs. The investment made in training an air traffic controller is even more useful if he or she can work in a remote tower centre and from there serve a number of different airports," says Per Ahl, Marketing Director for ATC solutions at Saab.

Another advantage with the remote tower solution is that costs savings can be achieved from existing towers that have reached the end of their economically viable service life need not be replaced.

"The remote tower concept enables an effective staffing for aerodrome control service and heavily reduces the costs related to build new or refurbish existing control towers," says Per Ahl.

The technical solution enables an airport tower to be remotely operated via a digital network. Compressed data from cameras at the airport provides a 360-degree real-time view of the airport at the remote tower centre. The controller working position is equipped with the same controls as in a normal tower.

Features such as object tracking and alerting, infra-red vision and image enhancement, are introduced in this new digital environment. This enhances the controller's situational awareness even in low visibility conditions.

In low visibility, the controller in a regular tower may not be able to see traffic at all. This can have an impact on air safety. Visibility enhancement technology in the remote tower concept helps the controller see what is going on in the aerodrome area, even if the visibility conditions are poor.

Low-visibility procedures, often causing delays, will be required less frequently with the remote tower system and punctuality will improve. Overlay of labels, meteorological information and a digital image enhancement improves the information available to the controller. Increasing the controller's situational awareness will lead to improved safety," says Per Ahl.

Another feature enhancing the concept's safety benefits is the possibility to record the camera generated view. This allows playback of traffic situations, useful for investigating incidents, etc.

Many airports in India do not have the intense air traffic situation that characterises the big hub airports. On the contrary, the normal picture for smaller airports is that most of the day there are a limited number of movements. In these cases, the remote tower is the perfect solution.

"The remote tower concept is a breakthrough for many airport operators. This solution could be exactly what small- and medium-sized airports in India need in order to meet the future requirements. The long-term benefits of this concept are the reduced costs related to the construction and maintenance of airport control towers, as well as more efficient air-traffic services (ATS)," says Per Ahl.

Technical Equipment

Remote Airport

- High-resolution digital cameras
- Pan-tilt camera with zoom capabilities (PTZ)
- Video encoding
- Microphones
- Signal light gun
- Metrological sensors
- Integrated tower systems (lights, navigational aids, distress alarms, etc)

Remote Tower Centre

- Up to 360 degrees of live LCD or projected airfield image
- Airfield stereo sound
- Pan-tilt-zoom camera and signal light gun controls
- Automatic weather observation system (AWOS)
- Integrated tower systems control
- Remote control monitoring system (RCMS) (airport lights, ILS, NDB, VOR, VHF/UHF, communication)
- Flight data processing system (FDP)
- Radar data processing (RDP) and display system
- Electronic flight progress strip system (e-Strip)
- Record and replay system for video, audio and flight information
- System redundancy
- Improved situational awareness
- Real-time object tracking
- Radar and video sensor fusion
- Labels for moving objects
- Geographical overlay during low visibility
- Image enhancement
- Zoom camera target tracking
- Zoom camera image incorporated into airfield view
- Visual gap filler ■

Contemporary & Upcoming

While maximum mileage is sought to be extracted by following a modular and 'off-the-shelf' approach, modern air-to-surface repertoire consists of a variety of family of weapons each possessing unique characteristics to suit their intended roles. The future is unlikely to be very different

By Air Marshal (Retd) A.K. Trikha

What attributes should an air-to-surface weapon possess for it to be called 'ideal' in the modern-day warfare scenario? What comes to mind in quick succession is that it should have precision, all-weather and stand-off capabilities. Then, it should match the intended target, be small enough to be carried in larger numbers on a launch platform and last but not the least, it should be cost-effective. Having identified the ideal attributes, it is obvious that no one size can fit all. There is no precise definition of precision. Its meaning is tied to the nature of the target which may be as different as an insurgent holed up in a cave several feet underground or a petrochemical refinery spread over several hundred metres. Similarly, requirement of 'standoff distance' may vary from a few km to several hundred km to avoid infringement of neutral territory to engage a target beyond. Therefore, while maximum mileage is sought to be extracted by following a modular and 'off-the-shelf' approach, modern air-to-surface repertoire consists of a variety of family of weapons each possessing unique characteristics to suit their intended roles. The future is unlikely to be very different.

An interesting example of how relatively simple and inexpensive technologies have been harnessed to increase weapons effectiveness by an order of magnitude is the joint direct attack munitions (JDAM). A typical example, JDAM in fact refers to an add on kit, which converts a variety of dumb warheads into 'smart' weapons. The kit consists mainly of a guidance and control section which is mounted at the tail of the bomb body. This section houses an INS unit, a GPS receiver, control electronics and cruciform tailfins to steer the bomb. The bomb body is also fitted with strakes to enhance its stability and gliding range. Using GPS-aided INS guidance, a JDAMs' accuracy is within 10 metres. However, if GPS is rendered ineffective due to jamming or any other reason, the accuracy still remains within 30 metres.

F-35 JSF: The supercruising fighter can release a small diameter bomb which can glide up to 60 nm

PHOTOGRAPHS: USAF

Weapons:
(Above) a weapons loader prepares a GBU-31 joint direct attack munitions, a joint direct attcak munition being inspected on a F-22

From typical operating altitudes, the stand off range of a JDAM weapon is of the order of 8 to 24 km. It is all-weather capable, fire-and-forget weapon. Its limitation against moving targets has been overcome by adding a Link 16 receiver through which the weapon receives continuous target position updates from an E-8C JSTARS. A laser seeker in the nose is a further refinement to enhance its ability to engage moving targets.

Similar technologies and greater aerodynamic refinements have been employed in a joint standoff weapon (JSOW) to produce a glide weapon with a stand-off distance of up to 120 km if released from high altitude. A further enhancement of the weapon consists of adding a Hamilton Sundstrand 150-pound TJ150 turbojet to the glide weapon which would increase its range to 300 nm. Raytheon conducted the first free-flight test of a powered, extended-range version of joint stand-off weapon in October 2009. It could be entering production in 2011. At $3,50,000 (₹1.58 crore) tag price, it would effectively turn JSOW into a low-cost, long-range missile.

With global positioning system (GPS) integrated inertial navigation system (INS) and fold out aerodynamic surfaces, a 'small diameter bomb' is another game changer in force-multiplication. Released from a supercruising F-22/ F-35 JSF, the weapon can glide up to 60 nm. The bomb's small size makes it possible to carry large numbers in the bomb bays of stealth aircraft. A B-2 bomber could carry between 192 to 216 SDBs in a single mission, thus endowing it with the potential to engage hundreds of separately identified targets within the bomb load's effective footprint. Aerodynamic surfaces enable the bomb to manoeuvre. Thus the delivery aircraft doesn't even have to be flying towards the target. The ability to hit scores of targets with pinpoint accuracy in a single pass adds an altogether new dimension to the attack capability of a task force.

Seen in terms of their efficacy, these and other similar weapons represent an exponential increase over the previous generation. Yet in some ways, it is an extension of the same line, i.e. making an explosive impact a target. However, evolution of a magic concept which has so far been the stuff of fantasy, i.e. directed energy weapons or 'ray guns' may well be approaching a critical mass. Several technology breakthroughs have moved high-energy lasers on fighters into the realm of the possible. Aircraft systems can now generate much more electric power necessary to produce laser beams with enough energy (about 100 kW) to be employable as a weapon at tactically significant ranges."Our strategy is simple," said Mike Booen, head of Raytheon Electronic System's Directed Energy programmes. "We want to replace high explosives with directed energy weapons (DEW). We want to replace any munitions or platforms that carry high explosives with DEW."

Many challenges undoubtedly remain before that vision can become a reality. However, the future may be closer than we think. ■

Cobham develops latest generation air-to-air refuelling systems

Legacy of Aerial Refuelling Innovation

By Group Captain (Retd) A.K. Sachdev

Much of the world's air-to-air refuelling equipment originates from Cobham. Its founding company, Flight Refuelling Ltd, first invented the probe-and-drogue method of refuelling in 1949 to meet a requirement from United States Air Force's (USAF) tactical air command for a system capable of refuelling their fighter jets. Today, the company's capabilities cover under wing pods for dedicated tankers, 'buddy' pods for smaller fast-jet aircraft, Fuselage Refuelling Unit's for centreline refuelling and the probes themselves to take fuel onboard combat aircraft and helicopters.

The current generation of Cobham pods is the 900 series electric drive pods, named on account of their 90 ft hose length which allows flexibility to refuel both fixed-wing and helicopters. Representing a step forward from the "fueldraulic" pods from the 1990s and earlier hydraulic systems, the 900 series has been developed in line with the latest generation of tankers. Mike Burke, Business Development Director, Cobham Mission Equipment, commented, "We have drawn on a legacy of aerial refuelling innovation to evolve our latest equipment in support of modern military operations and the increasing adoption of civil aviation safety standards."

The company's recent efforts have focused on the A330MRTT and the A400M tankers. Among the requirements for these aircraft was the need to be civil certified; accommodate a more robust environment; extend the speed range for hose deployment from 180-325 knots; drive the pods with variable-frequency power supply; and reduce weight and improve reliability and maintainability.

The electric drive pods designated for each respective aircraft feature a number of advancements; enhancing integration, maintenance, control and diagnostic benefits through a new digital control and monitoring system. The new hose-drum drive system central to each pod system offers a higher response capability then previous models, with dual redundant electric motor and drives to meet civil safety standards. For tankers with a third refuelling point, Cobham has also developed a Fuselage Refuelling Unit which shares the same hose drum system design as the pods and includes a modified version of the refuelling control unit. This role-fit self-contained unit, requiring only the power and fuel lines to be connected, will be used to refuel large aircraft. On adapting new pods to specific customer requirements, Burke says, "The data we have collected on existing systems obviously lowers the risk of creating any new systems and allows us to tailor the pod's design efficiently."

A330MRTT: Cobham's aerial refuelling innovation

Another product line for which Cobham has leveraged its existing technology is the 'buddy-buddy' store; a self-powered refuelling pod which is mounted on a fast jet fighter. The Cobham 754 pod is currently in service with the Indian Air Force Su-30 MKI.

Crucial to all pod applications is the drogue itself—the basket into which the receiver aircraft's probe connects. For the latest generation pods, a new patented high-speed variable drag drogue has been developed, providing an extended aerial refuelling speed range of 180 knots to 325 knots (330 ck/h to 600 km/h). These drogues combined with the 900 series pods enable a single tanker to support a variety of aircraft from rotorcraft to the latest generation fighter jets—a requirement of the Indian Air Force to employ a mixed fleet of long- and medium-range combat aircraft capable of both strike and air defence roles to achieve total tactical mission flexibility.

Multi-staged telescopic probes have been produced for both the JAS Gripen and V-22 Osprey based on the uniquely long reach probe design used in the company's patented aerial refuelling tank system. This provides a retractable telescopic probe within an external fuel tank to offer the F-16 a probe-and-drogue AAR capability. Working with Lockheed Martin, this concept has been evolved to fit the F-16 conformal fuel tank, known as the conformal aerial refuelling tank system (CARTS). Cobham has also provided different probe solutions for a number of other aircraft types, including the retractable probe for the US Navy, the US Marine Corps and international versions for the F-35 Lightning II joint strike fighter.

Looking to the future, as the concept of global reach becomes increasingly important and aerial refuelling systems are seen as a critical asset in meeting future needs, Cobham is working on systems to enable refuelling of UAVs. The company is a major subcontractor to Northrop Grumman on Defense Advanced Research Projects Agency's (DARPA) KQ-X Global Hawk air-to-air refuelling programme. ■

PHOTOGRAPH: COBHAM

Miscellaneous Use

Six decades after the first helicopter flew in the country, they are still not a very popular mode of travel in India. Yet global helicopter manufacturers are upbeat about the Indian helicopter market.

NEW HELICOPTERS:
S-92 (Left) , AW159 (Above)

By SP's Special Correspondent

From ferrying VVIPs to rescuing victims of natural or man-made disasters, the multifarious and indispensable roles a helicopter can play has made it the most versatile transport vehicle. Six decades after the first helicopter (civil and military) flew in the country, these are still not a very popular mode of travel in India. Yet global helicopter manufacturers are upbeat about the Indian helicopter market.

India's varied geographical terrain where construction of airports is not feasible and the growing threat from internal insurgencies seems to have raised the hopes of the international inc. After selling its first 100 choppers in India, Bell Helicopter expects to sell another 100 in less than five years. Likewise, Eurocopter eyes 50 per cent of India's helicopter market in the next five years and has opened a subsidiary in India. According to industry estimates, by 2013, about 90 helicopters could be added to the existing 288 helicopters in civil use. And all this despite the lack of infrastructure like heliports and maintenance, repair and overhaul (MRO) facilities.

On the military side, while AgustaWestland has bagged the order for 12 AW101 helicopters for $770 million (₹3,550465 crore), US Defense Security Cooperation Agency (DSCA) has notified the Congress of a foreign military sale (FMS) to the Government of India of a possible direct commercial sale (DCS) of 22 Boeing AH-64D Block III Apache helicopters worth $1.4 billion (₹6,300 crore). Further, 15 heavy-lift Boeing's CH-47F Chinook may come to India through the FMS route. The Hindustan Aeronautics Limited also has an order to deliver 65 light combat helicopters to the Indian Air Force (IAF) and 114 to the Indian Army.

WHAT'S NEW

S-92

Sikorsky has delivered its first two S-92 helicopters for utility operations in Afghanistan to airlift services provider AAR Corporation. AAR will perform passenger and cargo lift missions on behalf of the United States Transportation Command (USTRANSCOM), a government agency that provides transportation for the Department of Defense. Both aircraft are certified by the Federal Aviation Administration (FAA) to simultaneously carry both passengers and cargo in the same cabin space.

Sikorsky has delivered 129 S-92 helicopters since September 2004 to commercial customers in the oil and gas industry, search and rescue, VIP transport and utility sectors.

A military version of the S-92 airframe—the CH148 helicopter equipped for naval operations—is being designed and produced for the Canadian Government. Additionally, Sikorsky and Lockheed Martin have proposed a variant to the US Navy for the next 'Marine One' helicopter fleet to transport the President of the United States. The standard S-92 aircraft includes a spa-

PHOTOGRAPHS: SIKORSKY, AGUSTAWESTLAND & BOEING

cious cockpit with excellent exterior visibility, a stand-up cabin for up to 19 passengers, modern avionics with large NVG-compatible displays, a crashworthy fuel system separated from the passenger compartment, and a rear ramp for loading passengers or cargo.

BOEING'S HELICOPTER:
AH-64D Apache Longbow

Fire-X Medium-range VUAS

Northrop Grumman and Bell Helicopter's Fire-X medium-range vertical unmanned aerial system (VUAS) is a high-capacity unmanned aerial system based on the four-blade, single-engine Bell 407 helicopters. First flight of Fire-X was expected by the end of 2010. The new system also represents Northrop Grumman's entry in an anticipated US Navy competition in 2011 to demonstrate a new medium-range UAS.

Fire-X will incorporate Fire Scout's modular, field-proven architecture that accommodates a variety of intelligence, surveillance and reconnaissance (ISR) and communications payloads. It also provides complementary capabilities for missions that demand larger payloads (up to 3,000 pounds), longer endurance (more than 14 hours) and robust cargo hauling (up to 2,646 pounds external).

AW159

AgustaWestland's AW159 test aircraft has successfully completed its maiden flight. The aircraft, designated TI3, is the third of three test aircraft that will complete a 600-hour integrated flight test programme. This first flight comes just a few weeks after the second AW159, designated TI2, first flew in mid October. All the three aircraft flew together for the first time on the same day.

The first flight of the third AW159, known as Lynx Wildcat in UK military service, has marked another major milestone in the development of this new six-tonne multi-role military helicopter, 62 of which have been ordered by the UK Ministry of Defence. The first aircraft will be delivered by the end of 2011 with the aircraft becoming fully operational with the Army in 2014 and the Royal Navy in 2015. The British Army's AW159 Lynx Wildcat will perform a wide range of tasks on the battlefield including reconnaissance, command and control, transportation of troops and material, and the provision of force protection. The Royal Navy variant will provide an agile maritime capability providing anti-surface warfare capability and force protection and will operate in support of amphibious operations and be an important element in defending ships against surface threats. AgustaWestland has also signed partnering agreements with a number of key suppliers on the AW159 programme including Selex Galileo, a Finmeccanica company; GKN Aerospace, LHTEC, a partnership between Rolls-Royce and Honeywell, General Dynamics UK, Thales UK and GE Aviation.

K-MAX Helicopter

Kaman Aerospace Corporation's K-MAX helicopter can resupply troops with cargo air-dropped by parachute. The tests add a new delivery method for the 6,000-pound power lifter, which Lockheed Martin and Kaman have successfully transformed into an unmanned aircraft system for autonomous cargo delivery operations. Kaman has performed the airdrops using the Army's low-cost low-altitude cross parachute, a one-time use expendable aerodynamic decelerator that costs about $375 (₹16,875). Currently, used to airdrop supplies from manned aircraft in Afghanistan, the parachute is designed to handle 80 to 600 pound payloads delivered from 150 ft to 300 ft altitude above ground level.

Speed Hawk

PiAC's 'Speed Hawk' vectored thrust ducted propeller (VTDP) Compound Helicopter programme is an Army Advanced Technology Demonstration (ATD) programme to flight demonstrates potential improvements in speed, range, survivability and reliability, addressing the Army's Future Force requirements for greater rotorcraft operational reach and sustainability. The VTDP technology replaces the conventional tail rotor and provides anti-torque and yaw control with the additional ability to provide forward thrust and trim control. In combination with a lifting wing, this technology unloads the rotor, allowing the helicopter to fly 50 per cent faster, twice as far, is more manoeuvrable and reduces vibration and fatigue loads, improving reliability and reducing life cycle costs. The Speed Hawk's (X-49A) design, development and flight test programme is a primary example of PiAC's engineering, manufacturing and systems test capabilities. This programme, initiated as an SBIR Phase I effort has rsulted in the current army-sponsored advanced techonology demonstration (ATD) programme. ■

Making Forays into Aerospace Industry

Having completed the acquisition of these two companies, Mahindra Aerospace is now in consolidation and build-up mode. The company will be displaying the GA8 TC-320 Airvan at Aero India 2011 and is bringing the same aircraft that flew around the world last year for the event.

India's Mahindra Group, a global federation of companies with diversified interests, has been making calculated forays into the aerospace industry and is well on its way towards establishing a strong global presence in both aerostructures and utility aircraft.

The Group entered the aerospace industry in 2006 with the acquisition of Plexion Technologies, a Bangalore-based company with design and manufacturing experience in the aerospace domain, including the manufacture and export of 24 complete airframes and all production tooling for a specialty reconnaissance aircraft certified to FAR Part 23 in the US and Australia.

Since that time, the Group's footprint in the industry has expanded through both organic and inorganic growth, including its investment in Mahindra Satyam, which has a sizeable aerospace engineering services practice. More recently, through its subsidiary Mahindra Aerospace, the Group has entered the aerospace manufacturing sector with the recent acquisitions of two companies in Australia—Aerostaff Australia and GippsAero, active in the aerostructures and utility aircraft domains respectively—and is consolidating its growth with strategic investments in India.

Aircraft Interests

Even before the GippsAero acquisition, Mahindra Aerospace had expressed its interest in the utility aircraft sector by jointly undertaking a programme with India's National Aerospace Laboratories (NAL) to develop a five-seat utility aircraft—the NM5. The NM5 has been designed to augment the utility aircraft segment with a modern design that meets the latest safety and operational regulations, compared to several designs now in service that were designed in compliance with much older regulations.

NM5 Aircraft Developed by NAL and Mahindra Aerospace

The first flight of the NM5 is scheduled for mid-2011, followed by a further 12 to 18 months to achieve Type Certification and starting commercial production. The recently acquired subsidiary, GippsAero (GA) is now working with Mahindra Aerospace on the NM5. The GA acquisition complements Mahindra's interest in the aircraft market with its established global brand and in-depth knowledge of the global utility aircraft industry. GA has previously developed and marketed the GA200, an FAR Part 23 agricultural aircraft, followed by the development and entry into service of the GA8 Airvan, a FAR Part 23 certified eight-seat aircraft, which is already being sold in over 38 countries including the US, Australia, the European Union.

GippsAero's GA200 Agricultural Aircraft

GippsAero has a fully operational facility near Melbourne, Aus-

PHOTOGRAPH: MAHINDRA AEROSPACE

GA8 Airvan Highlights

- **Cabin Volume:** Large cabin, panoramic windows, large sliding access door and low cabin noise
- **Versatility:** Unique eight-seat multi-role aircraft that can be readily converted for freight/ passenger
- **Short take-off and landing (STOL):** Can be used in remote locations/ disaster relief camps giving it an edge over others.
- **Economics:** Unbeatable cost per seat mile cost efficient, easy maintenance, reliable operations platform, bigger cabin and superior load carrying capacity
- **Safety:** The only aircraft in its class certified to latest safety standards and meets the world highest airworthiness certification
- **Popular:** More than 150 aircraft, used for varied services in 35 countries around the globe
- **Choice:** Powered by the reliable Lycoming family of engines, it is available in normally aspirated and turbo charged variants with optional under slung cargo pods for even more volume

tralia. The facility (with access to an airstrip) is engaged in aircraft production, maintenance and product support activities and is approved by the Australian regulator CASA, the US Federal Aviation Authority (FAA) and the European Aviation Safety Agency (EASA).

GippsAero's GA8 Airvan

GippsAero is currently producing two variants of its eight-seat utility multi-role aircraft, the GA8 Airvan. Both versions are identical except for the power plant. The GA8NA uses a normally aspirated Lycoming IO-540, while the GA8 TC-320 uses a turbocharged Lycoming TIO-540. In all, more than 160 GA8 Airvans have been produced and sold to customers around the world. Both variants are certified by numerous regulatory bodies including CASA, FAA and EASA.

Powered by a Lycoming TIO-540-AH1A Turbocharged fuel injected engine, the GA8 TC Airvan has a cruise speed of 140 knots at 10,000 feet with 75 per cent power. In July 2010, two Australian pilots, Ken Evers and Tim Pryse successfully circumnavigated the globe in a GippsAero GA8 TC-320 turbocharged Airvan covering 28,000 nautical miles in close to 300 flying hours. With sponsorship from corporate parent Mahindra Aerospace, among others, the flight was made to celebrate 100 years of Australian aviation and to raise money for malaria awareness under the banner of 'Millions against Malaria'.

Several GA8 TC-320 Airvans have already been delivered to customers in Australia and New Zealand. Arvind Mehra, CEO, Mahindra Aerospace Private Limited (MAPL), said, "We are making substantial investments in our Australian facility—to ramp up production capacities for the GA8 to meet the market demand and to invest in new products and derivatives to expand our aircraft portfolio."

Aerostructures Interests

MAPL's other subsidiary, Aerostaff Australia, is a fully operational facility in Port Melbourne, Australia. This facility is a CASA approved AS9100 certified precision sheet metal components manufacturer, producing close tolerance high precision sheet metal components and assemblies for the aviation, defence and specialised sheet metal industries with vendor accreditation from several aerospace-defence majors worldwide.

With active participation of Aerostaff principals, Mahindra Aerospace is now working on setting up a new aerostructures manufacturing facility in India, which is scheduled to be completed in 2012. This will be a 2,00,000 sq ft facility with comprehensive capabilities for metallic aerostructural parts and assemblies. Towards this end, Mahindra Aerospace has acquired select equipment from an operational Boeing Aerostructures plant in Australia. This equipment will be re-commissioned in the upcoming India plant, where it will be the cornerstone of the new capabilities that are being introduced into the Indian aerospace industry.

India Plans

Having completed the acquisition of these two companies, Mahindra Aerospace is now in consolidation and build-up mode. The company will be displaying the GA8 TC-320 Airvan at Aero India 2011 and is bringing the same aircraft that flew around the world last year for the event.

As Mehra says, "Our current priority is to consolidate our achievements and build a strong foundation for ourselves in the global aerospace industry. This would be necessary to accomplish our strategic plans—commission the new Indian facility and quickly move up the value chain in aerostructures, as well as complete development and commercially launch the new aircraft models in the pipeline". He also mentioned, "For the aerostructures business we aim to establish ourselves as a Tier-1 supplier to large aircraft OEMs. On the aircraft side of the business we want to become globally recognised as a manufacturer of cost-effective, efficient, robust utility aircraft, producing and supporting a portfolio of four to six aircraft models."

In 2009, Mahindra announced two landmark aerospace deals with the simultaneous acquisition of a majority stake in two Australian companies, Aerostaff Australia, a Melbourne-based manufacturer of precision sheet metal parts and assemblies for the global aerospace and defence industries and GippsAero Pty Limited, an Australia-based manufacturer of utility aircraft. This move signaled Mahindra's strategic entry into the global aerospace components and general aviation markets. The company is since consolidating its growth with strategic investments in India. In parallel, MAPL is proud of its association with India's NAL for the development of a five-seat utility aircraft and have embarked on a plan to build a comprehensive aerostructures manufacturing capability in India.

Mahindra Aerospace is now proud to participate in Aero India 2011. The centerpiece of our stall (A-1) will be the newly launched GA8 TC-320 Airvan, designed and built by GippsAero. With more than 200 aircraft produced and in service across the globe, GippsAero enjoys a leading position in the field of utility aircraft. The Airvan is a unique eight-seat multi-role aircraft that can readily be converted to carry freight or passengers. Its global clientele find the aircraft ideal for a variety of operations including humanitarian relief, charter, tourism, medical evacuation, aero-sports (para jumping), surveillance, freight, and training. With robust metallic construction and powered by the reliable Lycoming family of engines, the Airvan is available in normally-aspirated or turbocharged variants.

Senior management teams from all three group companies—Mahindra Aerospace, GippsAero and Aerostaff Australia—will be available at Aero India to engage in discussions with prospective partners, suppliers and customers. Contact: Mahindra Aerospace Pvt. Ltd. on +91 (80) 42131459 or GippsAero on +61 (0) 351721200 or send us and e-mail on aerospace@mahindra.com. ■

Widening Gap

The fact that India's defence equipment needs are being met largely by imports, confirms the existence of a gap between its requirements and the ability of indigenous industry to meet them

At DefExpo 2010: Ashok Leyland's mine protected vehicle

By Lt General (Retd) Chandra Shekhar

A nation's military strengthemerge is determined by its economic might. The industry provides the wherewithal to fight a nation's wars. As a nation, India has for too long depended on foreign industries for its military hardware. The fact that India's defence equipment needs are being met largely by imports, confirms the existence of a gap between its requirements and the ability of indigenous industry to meet them. This gap is substantial.

In a rapidly expanding military-technology environment, the government supported research and development as well as their manufacturing facilities are proving increasingly inadequate to meet our total requirements. Imports continue to dominate our defence procurements, in value as well as volumes. The private industry, which could not participate in defence production earlier, has grown in size and reach. It has acquired modern manufacturing capabilities and the resources to invite competition from ordnance factories (OFs) and defence public sector undertakings (DPSUs). It is thus time that the private sector merited a rightful role in national defence.

The government has instituted new procurement structures and policies in recent years and has also created the Defence Acquisition Council under the Defence Minister. There has been some delegation of financial power to the defence forces as well. However, the changes have not been meaningful and taken to their logical conclusion. The attitude and mindsets have not changed. The decision-makers/structures also lack integrated authority for budgeting, technical development, production facility and planning national security needs, unlike in countries like UK, France and Canada where they have a separate dedicated procurement agency. The recent policy of 30 per cent "offset clause" for deals over ₹300 crore should give impetus to our indigenous defence industries. The recently signed joint venture with Israeli defence industry and Tatas for missiles, radars and electronic warfare system, and with Russian Federation for MiG-29 upgradation as also joint venture entered with the US, UK and French companies by Tatas, Larsen & Toubro and Mahindra for a number of weapon systems are good examples.

PHOTOGRAPHS: ABHISHEK / SP GUIDE PUBNS

On Display: Mahindra & BAE Systems Mine Protected Vehicle

The participation of the private sector is especially relevant in a climate when there are positive signs of a vibrant economy. It is now up to the nation to harness these energies. The way forward is to involve the industry in defence technologies and manufacture in a manner very different from what we are used to so far. The starting point is to build a partnership between the industry and defence—a partnership that is of a permanent nature.

Defence-Industry Partnership

To begin with, one must define partnership. To partner is to share. Partnership is not just interaction. It is a joint effort to achieve higher goals; a sharing of ideals and goals. The defence-industry partnership cannot be viewed only from the viewpoint of defence production. A much larger perspective, vision and goal should be the motive for this partnership—much beyond procurements and profits. Such a vision should be to create a self-reliant defence-industrial base for the country that will place India in league with leading military economic powers by the middle of the 21st century.

How is such a partnership to be forged? As a first step, what is required is a transformation in the traditional approach and attitude towards civil industry. The attitudinal changes warranted are:

- Recognise that defence is everybody's business—the industry as well as that of the military and of the government.
- Recognise that as defence looks for quality products, industry expects reasonable returns on its investments.
- Recognise that in any relationship, natural trust and benefits are the bedrock on which partnerships are built and nurtured.

Following from these attitudinal changes, the second step would be to identify existing strengths as well as existing lacunae. Equally important in the context of larger growth, is to envisage and take positive advantage of hitherto untapped potential. The fact that there exist networks of widely distributed units that cater to defence requirements can be turned into an asset. The present scenario of India importing defence requirements can also be turned on its head, by planning a future scenario when India exports defence items. Lessons can be learnt from successful examples in other nations, which are largely to do with commonsensical first principles.

To establish a long-term partnership between defence and industry, it is necessary to identify the requirements of the defence services. Thereafter, the industry's capabilities to meet these requirements both in the present as well as the future need to be established. The requirements of defence will include military technologies, weapon systems, equipment, and supplies of all types. The industry capabilities will encompass its research and development (R&D), manufacture and product-support facilities as well as its financial, infrastructure and human resource base.

In brief, a vision of a mutually-enriching partnership may be achieved by a combination of the following:

- Capitalising on defence industrial base and relevant PSUs that have already been established.
- Increasing participation by the civil industry with a view to capturing the vast export market.
- Developing advanced technologies through a distributed X-research/MNC participation.

Defence Procurement Process

All major procurements of defence equipment have come under public scrutiny in recent years. Various issues have been raised to highlight the inadequacies of the procedures being followed. The Ministry of Defence has always been criticised for not putting a proper organisation and procedure in place to ensure that the armed forces get the best equipment expeditiously. It has also been accused of lack of transparency in the whole process.

However, a path-breaking and bold step taken by the government has gone totally unnoticed by the media. In an unprecedented attempt to promote transparency, the newly evolved defence procurement procedure (DPP) was made public and put on the net in its entirety. The importance and enormity of this step has still not been grasped. Perhaps, no other country in the world has revealed its complete procedure in such a great detail. The Indian procedure covers all aspects from the selection of vendors to the evaluation process and the commercial negotiations.

Procurement of new weaponry and equipment in all countries is a long, complex and arduous process. A large number

of interdependent variables have to be factored in before a deal can be finalised. The average time taken for major acquisitions may extend up to five or six years. The problem gets compounded for India where the majority of critical equipment is procured from the foreign sources. Additionally, field trials have to be carried out in varying terrain and climatic conditions.

Fast Track Procedure

With a view to facilitate emergency acquisitions, a need was felt to have a fast track procedure which could be invoked in times of crisis, albeit with inherent checks to avoid its misuse. The government in September 2001 promulgated a fast track procedure (FTP). This procedure can be adopted only for the requirements, which relate to an imminent operational situation or a crisis without warning. Its need must emanate from the Service Chief and the proposal is put up to the Defence Minister with the recommendations of the Defence Procurement Board.

As the time is of essence in such procurements, FTP is confined to items which are likely to be available within the laid down timeframe. Long lead cases are avoided. It really implies that the items should already be in service or have already been trial evaluated. In exceptional cases, provisions permit sending of trial teams to the manufacturers' premises for quick evaluation.

The Way Ahead

Procurement of defence equipment in all countries is a highly intricate, delicate and time-consuming process. The new system has not been able to affect any significant reduction in the time taken as yet. An ingested timeframe for the induction of defence system and the whole process stage-wise so that the causes of delay could be identified and corrective action taken has been laid down in the new defence procurement procedure, but suffers from a "decision paralysis due to fears of scams/corruption". Procedures for various upgrades and system integration are yet to be formulated. Standard contract documents, which should protect the government's interests, are still ambiguous. Lack of an integral legal set up in the Ministry of Defence has hampered progress in this field. The Ministry of Defence is also seeking an arrangement for external audit of all procurement cases before the contracts are signed. This will help in taking timely corrective action or even in abort-

ing the case, if considered beyond redemption. It is thus evident that the potential of India's defence industry has not been fully exploited, with the result that the stated aim of promoting self-reliance remains elusive. Progress in this direction can be achieved by adopting the following strategies:

- **Adopt commercial standards, specifications, and protocol for subsystems and components:** We need to meet our needs mainly from commercial off-the-shelf products (COTS), to whatever extent possible, keeping in mind that defence-specific products are peculiar to each of its sectors (ships, aircraft, tanks, ammunition, electronics, etc) as well as keeping sight of the strict standardisation requirements.
- **Acquire necessary technology—current as well as emerging:** This should be done through joint and distributed research. Thus, defence supports R&D in industry and academia in certain identified specific areas. Similarly, government intervention and facilitation of financial support is essential to initiate the private sector into the production of defence equipment. At the same time, a firm commitment must be obtained from the industry. Restructuring of DRDO with a Defence Technology Commission under the chairmanship of the Defence Minister and creating a commercial arm in the DRDO are positive developments for better utilisation of technology.
- **Utilise all available national assets optimally:** This may be done by giving incentives and concessions for integration and sharing of infrastructure facilities as well as information, human resource and expertise. For this, it is imperative to create a network focused database of all information. The greater institutionalised participation by the private sector in major defence projects has also commenced i.e. future mechanised infantry combat vehicle (FMICV). The firm selected would get substantial government funding for research & development. The PSUs should be given greater freedom to form joint ventures, consortiums, etc.
- **Change in attitude to the reforms:** We need to turn these procedures into guidelines rather than rigid rules and make them simple transparent and efficient. An important step towards transparency would be to introduce an electronic procurement process and gradually move towards e-commerce in step with development in the corporate world.
- **Create consortia of industries to focus on collective responsibility:** To prevent unnecessary backtracking and speed up operations, institutionalise nodal/focal points for direct and frequent interaction of industry with the Services and the Ministry of Defence (MoD). Frequent joint seminars between the defence services and industry (such as CII and FICCI) taking place have helped in creating better partnership. This strategy and the progress of its implementation would naturally have to be monitored and adapted creatively to actual conditions. Finally, we have to remember that unless a conscious effort is made to change in a deliberate manner now, we will be forced to change in a less methodical way later. The commitment to change is a prerequisite to together build a long-lasting partnership that can transform the existing relationship.
- **Cost of trials:** No supplier ever provides any product at a loss. The concept of trials based on 'no cost no commitment" is impractical. These should be discussed and mutually agreed upon between the users and industry.
- **Export orientation:** It is a well known fact that for economy of scale and balance of payment benefits, exports are essential. India needs to factor this both for establishing tie-ups/linkages through joint ventures with major developed world for the state-of-the-art technology as also for arms transfer to potential buyers. The needs of strategic partners and friendly nations have to be built in the initial design board to make it an attractive proposition. Today, our export performance has been very moderate (2001-02 OFs made exports to the tune of just ₹35.3 crore).
- **Foreign direct investment (FDI) in defence industry:** Despite opening 100 per cent equity with 26 per cent FDI, the enthusiasm by the foreign investors to invest in Indian defence industry is not very encouraging. This is because every prospective FDI investor wants a fair degree assurance that the equipment produced will find buyers and ensure market. In the absence of no purchase guarantee by the government or dual use diversification or capacity utilisation by access to other markets, the foreign investor gets reluctant to invest and opts for countries like China, which provides investment incentives. Therefore, the policy for FDI in defence industry should be made more flexible and technology specific.

Steps Taken

A number of steps have been taken by the government to promote participation of industry in defence production. It needs to be followed up by all concerned with trust and faith i.e. users, OFs, DPSUs and the private industry. The interface between defence and civil industry in the DRDO is essential to optimise their R&D and production efforts. The government's recent policy reforms and the positive atmosphere of mutual trust and attitudinal changes among the stakeholders are essential for their interactive partnership to thrive. It is only the long-term partnership between defence and civil industry which can establish efficient use of resources, encourage innovation, and develop skills and technology to achieve self-reliance in defence preparedness. Defence Procurement Procedure 2005, for all capital acquisitions over ₹300 crore, stipulates requirement of 30 per cent offset obligation not only for the DPSUs and OFs but also the selected private industries. Implementation of this clause in letter and spirit will go a long way in strengthening the defence industries in India. The government also needs to give preference to induct indigenously produced equipment rather than the import option, even if it is slightly inferior but is operationally safe. This should be done selectively in a phased manner as also to promote exports at friendly prices as is being done by countries like China. ■

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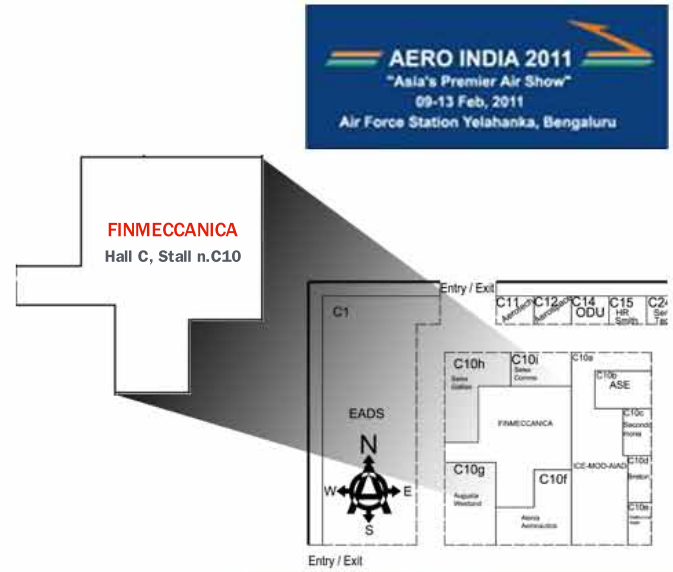

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MILITARY

Asia-Pacific

Release to Service Certificate for Tejas

Nearly three decades after it was first conceptualised, the initial operational clearance for the light combat aircraft was accorded on January 10, 2011, when the Defence Minister A.K. Antony handed over a formal Release to Service certificate of Tejas aircraft to Chief of the Air Staff, Air Chief Marshal P.V. Naik, at a function in Bangalore. The Release to Service certificate is prepared by Regional Centre for Military Airworthiness, an organisation under Centre for Military Airworthiness and Certification which has thoroughly scrutinised the entire design, development, equipment testing and the results of flight testing of all the systems of Tejas over the last several months. This is the first time an indigenously designed and developed military fighter aircraft is being certified for Air Force operations. This occasion marks a very important achievement in the design and development of Tejas in particular and military aviation in the country as a whole. After this, Tejas aircraft will be available for use by the Indian Air Force. Antony announced that the Government had cleared the next lot of 20 series production aircraft and there is a scope for supplying more of Mk2 variants to Navy and the Air Force.

Northrop Grumman demonstrates MR-TCDL capabilities

Northrop Grumman Corporation has successfully completed the second flight test phase of the multi-role tactical common data link (MR-TCDL) system, which provides real-time networking connectivity to warfighters and commanders by enabling extremely fast exchange of data via ground, airborne and satellite networks. This series of 14 flight tests verified the MR-TCDL system's capabilities, marking a critical milestone toward completion of the MR-TCDL developmental testing programme. For the flight tests, Northrop Grumman integrated MR-TCDL onto a Gulfstream II aircraft and a NASA ER-2 aircraft and digitally connected the aircraft to each other and to a series of ground entry points. The tests demonstrated the system's ability to reliably transmit data at rates greater than 200 megabits per second between multiple aircraft and ground networks as well as between aircraft at distances in excess of 270 nautical miles. This capability enables high-definition video teleconferencing and high-speed connection and extension of terrestrial wired and wireless networks access for senior leaders. The MR-TCDL system is built by L-3 Communications Systems-West, Salt Lake City.

AH-64D Block III Apache helicopters sale to India

The Defense Security Cooperation Agency has notified the US Congress on December 22, 2010 of a possible foreign military sale (FMS) to the Government of India of various engines, equipment, weapons, training, parts and logistical support for a possible Direct Commercial Sale of 22 AH-64D Block III Apache helicopters. The complete package is worth approximately $1.4 billion. In this competition, the Government of India is yet to select the Boeing-US Army proposal. This notification is being made in advance so that in the event that the Boeing-US Army proposal is selected, the US might move as quickly as possible to implement the sale. If the Government of India selects the Boeing-US Army proposal, the Government of India will request a possible sale of 50 T700-GE-701D engines, 12 AN/APG-78 fire control radars, 12 AN/APR-48A radar frequency interferometers, 812 AGM-114L-3 Hellfire Longbow missiles, 542 AGM-114R-3 Hellfire II missiles, 245 Stinger Block I-92H missiles, and 23 modernised target acquisition designation sight/pilot night vision sensors, rockets, etc. There are no known offset agreements proposed in connection with this potential sale.

Americas

Lockheed Martin's JAGM on Super Hornet

Lockheed Martin has successfully completed a comprehensive series of tests to demonstrate the flight characteristics of the US Navy's F/A-18E/F while carrying the joint air-to-ground missile (JAGM). The flying performance test series consisted of six flights with a total flying time of 11.2 hours. During each flight, the Super Hornet was refuelled in the air by a support tanker to enable the aircraft to reach all the required speeds and altitudes at which JAGM had to be tested. The JAGM test articles were six instrumented measurement vehicles equivalent in weight, size

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Afghan Air Force

• The first two Afghan Air Force helicopter pilots to complete basic pilot training in the US recently began the initial Mi-17 qualification course meant to convert them into Mi-17 helicopter pilots at the Afghan Air Force base in Kabul. A hybrid of Croatian and US helicopter training syllabi, the course is a six-month evolution that will qualify the pilots as helicopter aircraft commanders on the Mi-17.

AgustaWestland

• AgustaWestland, a Finmeccanica company, has announced that the Zhejiang Public Security Bureau in China has placed an order for two helicopters comprising one AW119Ke single engine and one AW139 medium twin-engine helicopter. The helicopters will be used for law enforcement and firefighting duties.

Airbus

• The European Commission has authorised Spain under EU State aid rules to grant an interest-free reimbursable loan of €129 million (about $175 million) to Aernnova for the development of the next-generation horizontal tail plane (HTP) of the future Airbus A350 XWB. The Commission found the state loan compatible with EU state aid rules, since the positive effects of the research and development aid outweighs any distortion of competition that the aid may bring about.

TUI Travel PLC, has become a new direct customer for Airbus, with an order for two A330-300 aircraft. The European travel group has ordered these aircraft for its French airline subsidiary, Corsairfly. The two wide-bodied A330-300s are the latest 235-tonne maximum take-off weight variants. This order takes the number of Airbus A330-300 customers to 324.

Airbus has delivered 15 corporate jets in 2010, worth more than $1.5 billion (₹6,750 crore) at list prices, setting a new record for this business. The aircraft comprised 13 A318 Elites, Airbus Corporate Jetliners (ACJs) and A320 Prestige jets, plus two VIP wide body A330/A340s. Airbus also won eight orders for its

and dimensions to tactical JAGM rounds and outfitted with resistive temperature devices, acoustic sensors and accelerometers to measure the flight environments experienced by the launchers and the missiles.

Europe

Boeing begins flight testing UK Chinook Mk4

Boeing and its Boeing Defence UK subsidiary announced on January 24 that the Boeing UK Rotorcraft Support team has begun flight testing the first Chinook Mk4 helicopter for the Royal Air Force (RAF). The first flight took place on December 9 in Hampshire, England. A major part of the modification for both the Mk4/4A and Mk5 aircraft is the Thales TopDeck cockpit. Thales UK is under contract with Boeing to supply its Cockpit Display System/Mission Avionic System, which will provide improved situational awareness, increased safety and options for capability enhancement. The upgraded and integrated cockpit display includes four multifunction displays, two standby flight displays, updated communications interfaces, and two new air data computers.

CIVIL AVIATION

Asia-Pacific

Aircraft charter specialist expands India operation

Air charter specialist Hunt & Palmer PLC has stepped up their activity on the Indian subcontinent with the formation of Hunt & Palmer Air Charter India Pvt Ltd, a new regional subsidiary. Active in the Indian markets since 2007, the Group's management has decided that the time is now right to expand operations in the country in order to meet the growing demand for private aviation there.

Speaking from the company's offices in New Delhi, Hunt & Palmer Air Charter India's Managing Director Aadesh Batra said, "These are exciting times for Indian aviation and the requirement for private aircraft charter has increased considerably over the last few years."

Europe

Lufthansa and Israel Aerospace Industries operating test

Lufthansa and Israel Aerospace Industries (IAI) have successfully conducted an operating test for the TaxiBot used with a B747-400 to demonstrate its ability to tow an airplane from gate to runway and back under typical taxiing conditions. The test was conducted at the Frankfurt International Airport. TaxiBot is a joint development by IAI's Lahav Division and Airbus of an innovative environmentally-friendly pilot-controlled semi-robotic towing system. The Taxibot Dispatch Towing system, designed by IAI, allows airplanes to taxi to and from the airport gate to the runway without the need to operate their jet engines.

INDUSTRY

Americas

Pratt & Whitney's STOVL variant F135 engine

Pratt & Whitney, a United Technologies Corporation company, has achieved initial service release (ISR) for the STOVL F135 engine, marking another major milestone. The propulsion system is now certified as the production configuration and cleared for flight in the Lockheed Martin F-35B stealth fighter. Pratt & Whitney received ISR for the conventional takeoff and landing/carrier variant F135 engine in February 2010. "Achieving initial service release for the STOVL propulsion system means all three variants of the F135 engine have met all necessary requirements and proven the safety, reliability and performance of this product. We are one step closer to powering operational flights," said Bennett Croswell, Vice President of F135/F119 Engine Programmes, Pratt & Whitney.

Boeing confirms P-8A Poseidon Airframe's structural integrity

Boeing announced that it had completed full scale static testing of the P-8A Poseidon's airframe on January 7. The series of tests, which began in May 2009, confirmed the airframe's structural integrity. The programme's full-scale static ground-test vehicle underwent 154 different tests in which it sustained loads equal to or greater than those expected to occur during operational flights, with no failure of the primary structure. During 74 of the tests, the airframe was subjected to 150 per cent of the highest expected flight loads. More than 4,000 installed strain gages and calibrated parts captured data for analysis.

Embraer closes out 2010 with 246 jets delivered

Embraer delivered 92 jets during the fourth Quarter of 2010 (4Q10), 30 of which to the commercial aviation market, 61 to executive aviation, and one to the defence segment. Thus, the Company closed out 2010 with 246 jets delivered. The firm order backlog, at the end of the year, came to $15.6 billion, which is 2

QuickRoundUP

corporate jets in 2010, taking total orders till date to more than 170 aircraft.

Thomas Cook Group has signed a firm order for 12 A321, as a first step of its single aisle fleet harmonisation and renewal plan which is based on the A320 family. The aircraft will be fitted with the latest fuel saving wingtip devices, known as Sharklets. In addition to the firm order, Thomas Cook Group plans to lease A320 Family aircraft from operating lessors.

ATK

• ATK has announced that it has been selected to provide the Thermal Control Subsystem for the Integrated Sensor is Structure (ISIS) programme. The contract, awarded by Lockheed Martin, is a critical component of the Defense Advanced Research Projects Agency ISIS Airship. Lockheed Martin leads an industry team in the development of an airship-based autonomous unmanned sensor with unique capabilities to track ground and air targets.

Boeing

• Boeing has announced that it has successfully conducted its first over-the-air ground test of a Ka-band satellite communications (SATCOM) phased-array antenna system that will enable wideband SATCOM on aircraft, providing increased bandwidth for networking in flight. This third-generation antenna system gives commercial and military aircraft operators worldwide the ability to offer communications using the growing fleet of commercial K- and Ka-band satellites.

Boeing Training & Flight Services has signed a long-term agreement with Blue1 to provide 717 training capabilities in Stockholm, Sweden, beginning the first quarter of 2011. Blue1 is a Scandinavian Airlines' subsidiary based in Helsinki, Finland.

American Airlines has ordered two new GE90-115B-powered Boeing 777-300ER aircraft. The aircraft will be delivered in late 2012. The Boeing 777-300ER, 200LR and 777 Freighters powered by GE90-115B engines have been highly popular aircraft/engine combinations. More than 580 of these aircraft have

per cent higher than the amount recorded on September 30, 2010.

The last quarter of the year was marked by the certification and beginning of operations of a new Embraer executive jet. The large cabin Legacy 650 is based on the successful Legacy 600 platform. Throughout 2010, the commercial aviation market showed concrete signs of recovery and gradually regained its business activity. Consequently, Embraer sealed contracts for the sale of 97 new airplanes, which is very close to the 100 deliveries made.

Europe

Airbus celebrates its 10,000th order

On January 17, Airbus announced its 10,000th order with a firm contract from Virgin America for 60 A320s, including 30 A320neo aircraft. This is the first firm order for the A320 new engine option; therefore Virgin America becomes the launch customer for the A320neo. This formalises and expands an initial commitment given at the Farnborough International Airshow in July 2010 with the inclusion of the A320neo as a new development in that deal. The 30 A320s will feature fuel-saving large wing tip devices called Sharklets. Virgin America has not yet announced its engine choice on the newly ordered A320s or the A320neo. Seating configuration on the aircraft will be the same as its existing A320 fleet (146-149 seats) in a two-class configuration.

The A320neo responds to heightened customer environmental interest, offering a 15 per cent reduction in fuel consumption. The option was launched in late 2010 for first deliveries in early 2016. Airlines have the choice between CFM International's Leap-X engine and Pratt & Whitney's PurePower PW1100G engine. Each variant of the A320neo incorporates Sharklet wing tip devices. In addition to fuel savings, the A320neo will benefit from a double-digit reduction in NOx emissions, reduced engine noise, lower operating costs and up to 500 nautical miles more range or two tonnes more payload.

Fatigue testing of Airbus Military A400M begins

Major fatigue testing of the Airbus Military A400M has begun on schedule in Dresden in January. The test airframe, known as MSN5001, will be subjected to a punishing regime of loads, 24 hours per day, for an initial four weeks, eventually simulating 160 flights per day. The first 1,665 simulated flights are required for European Aviation Safety Agency (EASA) type certification of the A400M, but over the next 18 months a total of 25,000 simulated flights will be performed— equating to 2.5 times the A400M's design-life. Static testing of another A400M test airframe, MSN5000 was completed in Madrid in September 2010. That airframe continues to be used for further fatigue tests of composite structures which will last until early 2012.

Rolls-Royce & British Airways Trent engine contracts

Rolls-Royce, the global power systems company and British Airways have completed contracts for Trent 900 and Trent 1000 engines to power up to 61 new wide-body aircraft. The order, originally announced in September 2007 and worth in excess of $5 billion (₹22,500 crore) at list prices if all options are exercised is for Trent 900 engines to power 12 Airbus A380 aircraft, with a potential additional seven options, and Trent 1000 engines to power 24 Boeing 787 Dreamliners, with 18 options. The contracts include TotalCare long-term support agreements.

British Airways is one of the nine customers that have selected the Trent 900 for the Airbus A380. The Trent 1000 has been selected to power the first Boeing 787 to enter service with Japanese airline All Nippon Airlines and has already powered over 2,000 hours of aircraft test flights.

SPACE

Americas

Lockheed Martin multi-mission satellite operations centre

Lockheed Martin announced that the satellite command and control system—the multi-mission satellite operations centre ground system architecture—recently went operational with the successful launch of the multi-payload experimental Space Test Programme STP-S26 mission, STPSat-2. The architecture was developed by Lockheed Martin and the US Air Force's Space and Missile Systems Center Space Development and Test Directorate.

Using Lockheed Martin's horizon satellite command and control framework, Multi-Mission Satellites Operations Centre (MMSOC) Ground System Architecture (GSA) consolidates satellite operations by providing over-arching ground segment architecture for one-of-a-kind technology demonstrations and responsive space operations. The Space Development and Test Directorate develops, tests and evaluates air force space systems, executes advanced space development and demonstration projects, and rapidly transitions capabilities to the war fighter. ●

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been ordered by 43 customers worldwide.

Representatives of Boeing, its suppliers and the Netherlands Ministry of Defence marked the first flight of the Royal Netherlands Air Force (RNALP) Chinook heavy-lift helicopter in a ceremony at Summit Aviation in Middletown. The RNLAF has ordered six CH-47F (NL) Chinooks to enhance its current fleet of 11 CH-47D (NL) aircraft.

Boeing and Alaska Airlines have announced an order for 15 NextGeneration 737 airplanes, comprised of 13 737-900ERs (extended range) and two 737-800s. The 737-900ER is a new model for the Alaska Airlines fleet. The contract, which includes exercised options previously placed by Alaska, is valued at $1.3 billion (₹5,850 crore) at list prices.

Boeing has received a $1.6 billion (₹7,200 crore) contract from the US Navy for low-rate initial production (LRIP) of the P-8A Poseidon aircraft. The LRIP 1 contract is for six P-8A aircraft, spares, logistics and training devices. The Navy plans to purchase 117 of the Boeing 737-based P-8A anti-submarine warfare, anti-surface warfare, intelligence, surveillance and reconnaissance aircraft to replace its P-3 fleet.

Bombardier

• Bombardier Aerospace today announced it has received firm orders from an undisclosed customer for two Challenger and six Global jets. The transaction is valued at approximately $383 million (₹1,724 crore) based on the 2010 list price for typically equipped aircraft.

CAE

• CAE USA has been awarded a contract valued at approximately $44 million (₹1,980 crore) to design and manufacture two MH-60R tactical operational flight trainers (TOFTs) for the US Navy. The first simulator will be a fixed-based MH-60R TOFT delivered to Naval Station (NS) Mayport near Jacksonville, Florida in mid-2013. The other MH-60R TOFT, which will also be reconfigurable to the MH-60S helicopter variant, will be a full-motion simulator delivered to the Naval Air Facility (NAF) Atsugi, Japan in the summer of 2014.

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