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AERO INDIA 2007
6th International Aerospace
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.....PG 40

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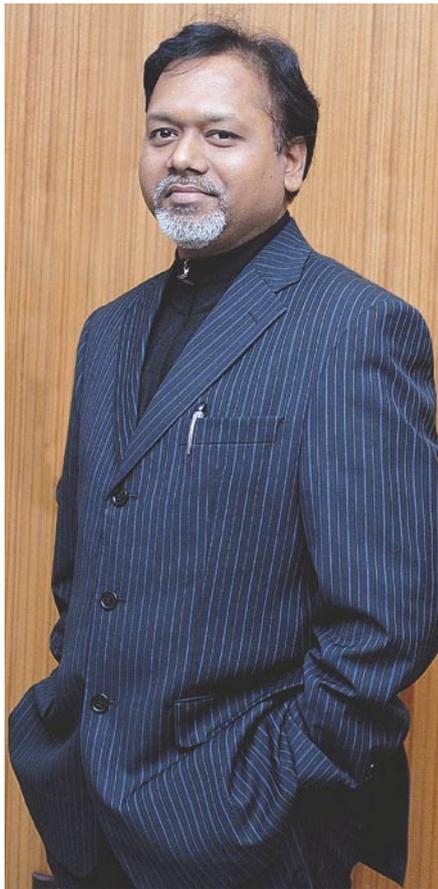
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**SP GUIDE
PUBLICATIONS**



This *Special Supplement*, being brought out on the occasion of Aero India 2007, is a rich repertoire of subjects that give deep insights into both civil and military aviation as well as security and defence issues. Our opening article written by UK-based senior journalist Alan Peaford analyses how post 9/11 homeland defence is being taken up on a war footing by the US that is planning to earmark an expenditure of US \$42 billion in fiscal 2007 for the purpose. Taking a cue from the US, many countries around the world are in the process of developing their own homeland defence departments.

Forty countries are operating more than 80 types of UAVs. The US alone is operating at least 18 types with 3000 UAVs on its inventory. UAVs are offering new horizons for air and space operations. A comprehensive and well-researched article by Lt General (Retd) V K Kapoor on worldwide evolution and development of UAVs has been included in this publication. Reporting from UK, Brendan Gallagher gives us a virtual ringside view of the design wars between Airbus and Boeing. Both manufacturers say publicly that their current products have years of development life left in them yet. But behind the scenes they are quietly aggregating technologies, looking to the day when an all-new package will make sense. In another article, Peaford describes the boom time in business aviation. But, he says that India and its neighbours may hold the key to the rapidly growing business aviation market that is taking the world by storm.

Lt General (Retd) Naresh Chand, while discussing the current upgrade choices available for military helicopters recommends that the thrust for the 'mean machines' should be better day and night capability, situational awareness and enhanced survivability. India's growing civil aviation density needs matching increase in airport infrastructure. Philip Nasskau suggests that opportunity exists for India's airports to achieve the highest technological standards in their infrastructure. Articles on Army Air Defence and Army Aviation cover their modernisation plans. An article on EW and protection systems for fighter pilots gives details of a few systems available to increase the survivability of military aircrafts in the dense and lethal air defence environment. Air Marshal (Retd) B K Pandey reporting from Bangalore, the home of the aviation industry, concludes optimistically that the Indian aircraft industry is on the path to globalisation, thanks to collaborations with leading world aerospace companies.



Jayant Baranwal
Publisher & Managing Director



P-3



MH-60R



C-130J



F-16 with Sniper Targeting Pod



PAC-3

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TAKING A CUE FROM THE US, MANY COUNTRIES AROUND THE WORLD ARE IN THE PROCESS OF DEVELOPING THEIR OWN HOMELAND DEFENCE DEPARTMENTS

Alan Peaford UK

US HOMELAND DEFENCE

MASSIVE PROTECTION MACHINE

In the aftermath of the events of 9/11, the US speedily set up the Department of Homeland security (DHS) which has now grown into a massive machine to protect the US. The budget request for fiscal 2007 is in the region of US \$42 billion which gives a clear indication of the massive nature of the project.

In the words of the organisation itself: "The National Strategy for Homeland Security and the Homeland Security Act of 2002 served to mobilise and organise our nation to secure the homeland from terrorist attacks. This exceedingly complex mission requires a focused effort from our entire society if we are to be successful. To this end, one primary reason for the establishment of the Department of Homeland

Security was to provide the unifying core for the vast national network of organisations and institutions involved in efforts to secure our nation. In order to better do this and to provide guidance to the 180,000 DHS men and women who work every day on this important task, the Department developed its own high-level strategic plan. The vision and mission statements, strategic goals and objectives provide the framework guiding the actions that make up the daily operations of the department."

DHS: The US Version

Many countries around the world are in the process of developing their own homeland defence departments; however it is important to

Hot



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recognise that the original US version of the DHS is distinct from the US Department of Defence and covers a much wider brief than simply counter terrorism. The threat from for example, avian flu, comes within the purview of the DHS.

The mission statement of the DHS is as follows: 'We will lead the unified national effort to secure America. We will prevent and deter terrorist attacks and protect against and respond to threats and hazards to the nation. We will ensure safe and secure borders, welcome lawful immigrants and visitors, and promote the free-flow of commerce.

Strategic Goals

Awareness: Identify and understand threats, assess vulnerabilities, determine potential impacts and disseminate timely information to our homeland security partners and the American public.

Prevention: Detect, deter and mitigate threats to our homeland.

Protection: Safeguard our people and their freedoms, critical infrastructure, property and the economy of our nation from acts of terrorism, natural disasters, or other emergencies.

Response: Lead, manage and coordinate the national response to acts of terrorism, natural disasters, or other emergencies.

The sheer size of the DHS covers an extraordinarily wide gamut of operations including, in no

particular order, screening port workers; evaluating security of mass transit and passenger rail system; running the US Coast Guard; awarding contracts to support emerging counter MANPADS (man portable air defence systems); rebuilding the Federal Emergency Management Agency (FEMA) after the catastrophic Hurricane 'Katrina'; coordinating the pandemic influenza preparedness activities across a number of departments. The DHS planning scenarios provide 'all hazards' scenarios for nuclear, biological and chemical attack, among other threats, and allow responsiveness and capability to be analysed across the US.

C4ISR – the DHS version

The Security Information Network is an interesting example of the sophisticated nature of one of the ongoing programmes. The Homeland Security Information Network initiative is expanding its internet-based counter terrorism communications network to all 50 states, five territories, Washington DC and 50 major urban areas to strengthen its real-time, collaborative flow of threat information to state and local communities.

Secure Information System

The Homeland Security Information Network significantly strengthens the real-time, exchange of secure threat information to state and local bodies at the Sensitive-but-Unclassified level (SBU). Future programme expansion will include

the county level, communication at the classified secret level, and the involvement of the private sector. The system is encrypted at the most secure levels ensuring the safest delivery of real-time interactive connectivity among state and local partners, and with the Department's Homeland Security Operations Centre (HSOC) using the Joint Regional Information Exchange System (JRIES), which consists of a secure network and a suite of applications including mapping and imaging capabilities.

State and Local Information Sharing

Each state and major urban areas' participants include, governors, mayors, Homeland Security Advisor, state National Guard offices, Emergency Operations Centres, First Responder and Public Safety departments, and other key homeland security partners. Each receives software licenses, technology, and training to participate in combating terrorism, information sharing to combat terrorism and increase anti-terrorism situational awareness. Information sharing to reduce vulnerabilities is an essential element of the Department's mission, and this real-time flow of encrypted information between homeland security partners will allow federal, state and local agencies to better perform their jobs of protecting the nation. This increased connectivity will result in more effective communications and more efficient responses to terrorist actions.



Alan Peatford

Countries around the world are in the process of developing their own homeland defence departments.

Hotter



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- Media studies and analysis
- Mapping & imaging (national, state, county, city)
- Critical Infrastructure Protection (CIP) information
- Strategic analysis of terrorist threats, tactics and weapons

Strengthening Interoperability Communications

Since 2003, DHS has provided over US \$2.1 billion to states for interoperable communications equipment, planning, training, and exercises. Through the Interoperable Communications Technical Assistance Programme, DHS has provided onsite assistance to improve interoperable capabilities in more than 75 states, urban areas, and metropolitan regions. Through the Department's RapidCom initiative, first responders and incident commanders in ten high-threat urban areas now have the ability to communicate with each other and their respective command centres in the event of a large emergency incident like a terrorist attack. These cities include: Boston, Chicago, Houston, Jersey City, Los Angeles, Miami, New York, Philadelphia, San Francisco, and Washington DC. To further assess the capacity for communications interoperability among law enforcement, fire, and emergency medical service first responders in all 50 States and DC, DHS initiated the National Interoperability Baseline Survey which will result in a public score card that will identify gaps and help in determining improvements needed to be made in the near term. ■



Gripping Gripen

SAAB of Sweden – the manufacturer of Gripen, the fourth generation, multi-role combat aircraft (MRCA), are on a hard sell. A bill board advertising the product came up as early as on January 27 along the road to Yelahanka air base at Bangalore – the venue for Aero India 2007. It is rare to see a foreign aircraft being advertised on a roadside bill board in India! Two double-seater Gripen aircraft with serial numbers 824 and 826 and one single seater with serial number 229 landed at the air base just before dusk on January 29 – the first foreign aircraft to reach the air show. At the venue, SAAB has taken up a corner stall at the new hangar with wide spaces. An empty space is referred to as, 'for the flight simulator'.

Gripen will be competing with Mirage of France, F-16 and F-18 from Lockheed Martin and Boeing and MiG 35. The Deputy Prime Minister of the Russian Federation, Sergey Borisovich Ivanov was confidently promoting MiG 35 on January 23 at Bangalore. Asked what incentives Russia was offering to beat the competition, he said, it included maintenance and later gradual manufacturing of jet engines going into the MiG 35 at Hindustan Aeronautics Limited. This would bring down the cost, he added.

- Squadron Leader (retd) B G Prakash, Bangalore

The competition to offer 126 or possibly 200 MRCAs for the Indian Air Force is, indeed hotting up. After the air show, evaluation of the contender aircraft is likely to take place at Yelahanka, from February 12 to 15.

Hottest



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Lt General (Retd)
V K Kapoor

UAVS ARE OFFERING NEW HORIZONS FOR AIR AND SPACE OPERATIONS AS THEY BEGIN TO FUNCTION MORE LIKE VERY LOW-ORBIT, PERSISTENT SATELLITES THAN LIKE AIRCRAFT

UNMANNED AERIAL VEHICLES

SPATIAL HORIZONS

UAVs are remotely piloted or self-piloted aircraft that can carry cameras, sensors, communications equipment or other payloads. They can be used for reconnaissance, intelligence-gathering, real time imagery, surveillance of a designated area and for attack. More challenging roles have been and are being envisioned which include combat missions with specialised platforms. They can fly autonomously based on pre-programmed flight plans or more complex dynamic automation systems.

Developments

Over the last few years, the US and Israel, especially the latter, have been largely responsible for much of the development that has happened in the UAV sector. The Hunter and the Pioneer, which are used extensively by the US military, are direct derivatives of Israeli systems. The Pioneer was used in the Gulf War to good effect.

The Predator, an Advanced Technology Demonstration Project, demonstrated its worth in the skies over the Balkans. Another popular UAV is the Global Hawk which proved invaluable in Afghanistan and in Iraq in 2003.

UAV Types

UAVs typically fall into one of five categories (although multi-role airframe platforms are becoming more prevalent):

- **Target and Decoy:** Providing ground and aerial gunnery a target that simulates an enemy aircraft or missile
- **Reconnaissance:** Providing battlefield intelligence
- **Combat:** Providing attack capability for high-risk missions (called Unmanned Combat Air Vehicle [UCAV])
- **Research and Development:** Used to further develop UAV technologies.
- **Civil and Commercial UAVs:** UAVs specifically designed for civil and commercial applications.

UAV Categorisation

Since 1964 the US Defense Department has created 11 different UAVs, though due to acquisition and development problems only three entered production. The US Navy has studied the feasibility of operating Vertical Take-off and Landing (VTOL) UAVs since the early 1960s; however, high cost and technological immaturity have precluded acquiring and fielding operational VTOL UAV systems. By the early 1990s, the Defence Department sought UAVs to satisfy surveillance requirements in Close Range, Short Range or Endurance categories. Close Range was defined to be within 50 kilometers, Short Range within 200 kilometers and Endurance as anything beyond. By the late 1990s, the Close and Short Range categories were combined, and a separate Shipboard category emerged. The current classes of these vehicles are the Tactical UAV and the Endurance category.

Predator about to land after reconnaissance mission.



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MINI & MICRO UAV SYSTEMS	BIRD EYE 400 	MOSQUITO 

MULTI-ROLE MALE UAV SYSTEMS	HERON 	EAGLE 
CLOSE-RANGE TACTICAL UAV SYSTEMS	RANGER 	I-VIEW 

CHARACTERISTICS OF UAVS OF THE WORLD

Sr. No./ Country	Name/ Company	Wing Span (meters)	Length (meters)	Height (meters)	Max Speed
CANADA					
1.	CL-89/ CANADAIR LTD	0.94	2.6	?	740 KPH
2.	CL-289/ CANADAIR LTD	1.32	3.61	?	720 KPH
3.	CL-327/ CANADAIR LTD	rotor span4	1.83	?	157 KPH
CHINA					
4.	WZ-2000	9.8	7.5	?	800 KPH
5.	ChangKong-1	7.5	8.44	2.96	800 KPH
FRANCE					
6.	MART II/ ALTEC	3.4	3.2	?	195 KPH
7.	CRECERELLE/ SAGEM 3,050	3.3	2.4 120	0.7	240 KPH
8.	SPERWER/ SAGEM	4.3	2.7	?	240 KPH
9.	FOX-TX/ CAC SYSTEMES	4	2.75	?	180 KPH
10.	K100/ CAC SYSTEMES	2.6	1.5	?	234 KPH
11.	HELIOT/ CAC SYSTEMES	rotor diameter6.7	6		126 KPH
12.	VIGILANT/ TECHNO-SUD & THALES	rotor diameter1.83	2.3	?	97 KPH
GERMANY					
13.	KZO/ EURODRONE	3.4	2.26	0.9	250 KPH
14.	LUNA/ ATN	3.98	2.04	?	190 KPH
ITALY					
15.	MIRACH 26/ METEOR	4.73	3.85	1.27	220 KPH
16.	MIRACH 150/ METEOR	2.1	4.7		855 KPH
ISRAEL					
17.	MASTIFF/ MALAT [IAI]	4.25	3.3	0.89	185 KPH
18.	SCOUT/ MALAT[IAI]	4.96	3.68	0.94	176 KPH
19.	SEARCHER/ MALAT IAI	7.65	5.1	1.25	200 KPH
20.	SEARCHER II MALAT IAI	8.54	5.85	?	200 KPH
21.	EYE -VIEW/ MALAT IAI	3.96	2.9	?	185 KPH
22.	SNIPER/ SILVER ARROW	5.2	3.8	?	175 KPH
23.	MICRO -V/ SILVER ARROW	3.7	2.74	?	185 KPH
24.	HERMES 180 / IAI				
25.	HERON	16.60	8.94		207 KPH
PAKISTAN					
Employs indigenous and Chinese UAVs - Details not known.					
RUSSIA					
26.	SHMEL-1 /YAKOVLEV 2,900	3.23	2.77 129		140 KPH
27.	KA-137 /KAMOV	rotor width: 5.3	body diameter: 1.22 meters		175 KPH



Heron demonstrates long endurance.

SP Guide Pubns

Miniature and Micro UAVs

Smaller, tactical UAVs are being developed to support tactical units with very short range "over the hill" and "around the corner" intelligence, and assist in force protection. While each mission requires a different profile and capabilities, the man portable Miniature Aerial Vehicles (MAVs) are designed to provide reasonably good performance at an affordable price. To effectively support the field troops, smaller UAVs are designed, ranging from man portable (back packable) systems to insect-sized "mesicopters", and miniature "smart dust" sensors. They can be launched by hand, deployed by larger UAVs, or ejected from artillery or mortar projectiles, as expendable sensors. These systems are broadly designated as MAV. Current systems are relatively large for a "micro" designation. However, new electro-opto-mechanical integrated micro systems currently in research and development stage will enable these systems to be much smaller, so as to monitor and sense the battlefield, and to engage and defeat a wide variety of hostile targets across the entire spectrum of conflict.

Some of the missions suggested for MAVs include section (squad) level combat, battle damage assessment, air or artillery observation, sensor dispersal, relay communications, and detection of mines and hazardous substances. MAVs could also be equipped with small jamming systems to confuse radar or communications equipment at very short range. MAVs capable of hovering and vertical flight could be used to scout out buildings for urban combat and for counter terrorist operations. A MAV could also be included in an airman's survival kit, used by a

Endurance	Ceiling (Meters)	Weight (Kilograms)	
		(Payload)	(Launch Weight)
?	?		108
40 minutes	?		220
6.25 hours	5,500	350	
3 hours	18,000	1700	
?	18,000	2000	
4 hours	3,050		110
5 hours			
5 hours	5,000		320
5 hours	3,000	30	135
30 minutes		5	28
2 hours	3,000	120	450
30 minutes			
1 hour	1,830		40
4 hours	4,000		150
4 hours	2,740		20
> 6 hours	3,500	50	200
1.3 hours	9,150		345
7.5 hours	4,480	37	138
7 hours	4,575	38	159
12 hours	5,180	68	400
18 hours	6,100		500
> 6 hours	1,525	13.6	104
> 6 hours	4,575	25	155
5 hours	4,570	8,2	50
10 hours	4,575		
52 hours (demonstrated)	10,000	200	1,100
2 hours			
4 hours	3,500		280

Sr. No./ Country	Name/ Company	Wing Span (meters)	Length (meters)	Height (meters)	Max Speed
SWISS					
28. USA	RANGER/ OERLIKON	5.7	4.6	1.13	220 KPH
Endurance UAVs					
29.	RQ-1 PREDATOR/ GENERAL ATOMICS	12.7	8.14		130 KPH
30.	RQ-4A GLOBAL HAWK/ NORTHROP GRUMMAN	35.4	13.5	4.6	650 KPH
Tactical/ Battlefield UAVs					
31.	PIONEER/ MAZLAT & AAI	5.15	4.26	1	185 KPH
32.	POINTER/ AEROVIRONMENT Incorporated	2.74	1.83		73 KPH
33.	AQUILA/ LOCKHEED	3.88	2.08		210 KPH
34.	HUNTER/ IAI & TRW	8.9	7	1.7	200 KPH
35.	SKYEYE/ DEVELOPMENTAL SCIENCES CORPORATION	7.32	4.1		200 KPH
36.	OUTRIDER/ ALLIANT TECHSYSTEMS	3.38	2.84		220 KPH
37.	SHADOW 200/ AAI	3.89	3.41		225 KPH
38.	SHADOW 600/ AAI	6.83	4.70	1.22	210 KPH
39.	DRAGON DRONE/ BAIA AEROSYSTEMS	2.44	1.52		130 KPH
40.	EAGLE EYE/ BELL	4.63	5.46		322 KPH
41.	SENTRY/ S-TEC	3.35	2.24		175 KPH
42.	SENTRY HP/ S-TEC	3.90	2.57		185 KPH
43.	SENTRY (Neptune)/ S-TEC	2.13	1.83		155 KPH
44.	SCARAB/ RYAN AIRCRAFT CORPORATION	3.35	6.12		970 KPH
45.	BQM-145A/ RYAN	3.2	5.6		1,115 KPH
46.	GOLDENEYE/ AURORA	3.0		1.7	295 KPH
47.	SCORPION/ FREEWING	4.9	3.60		235 KPH
48. UK	INSITU AEROSONDE/ AEROSONDE	2.9	1.74		103 KPH
49.	PHOENIX/ BAE SYSTEMS	5.6			166 KPH

downed pilot to keep track of approaching enemy search parties, or relay communications to search and rescue units. US has conducted tests with many types of MAVs (less than 15 cms). However these types of UAVs do not seem to have been deployed operationally at present.

The maximum flight duration of UAVs varies widely. Internal combustion engine aircraft endurance depends strongly on the percentage of fuel burned as a fraction of total weight and is largely independent of aircraft size. Solar electric

UAVs hold the potential for unlimited flight, a concept championed by the Helios Prototype, which unfortunately was destroyed in a 2003 crash.

Civil and Commercial Applications

Unmanned aircraft are slowly finding their way into civil and commercial applications. Governments are looking into using UAVs for surveillance over high crime areas, in order to prevent crimes from happening and for counter terrorist operations by police and paramilitary forces.

They could also be used to control 'hot spots', where violence takes place habitually. Some of the areas for commercial use include mineral exploration, telecommunications, news broadcasting, air traffic/ground traffic control, crop monitoring, weather research, among others.

Unmanned Combat Air Vehicle

The Unmanned Combat Air Vehicle (UCAV) or "combat drones" is the name of a new class of UAVs that have been designed to carry out air



Endurance	Ceiling (Meters)	Weight (Kilograms)	
		(Payload)	(Launch Weight)
5 hours	4,575	39	270
24 hours	7,600		686
34 hours	20,000	3,850	10,400
> 6 hours	4,575	45	190
1 hour	300		4.1
3 hours	4,500	52	150
12 hours	4,570	590	725
> 8 hours	4,570	82	567
4.5 hours	4,570	63.5	193
> 5 hours	4,575	27.2	149
14 hours	5,180	163	272
3 hours	3,000	25	43
8 hours	6,100		910
8 hours	4,880	59	109
8 hours	4,880	81.6	147
4 hours	4,880	9.1	36.3
	13,100		1,130
	12,200	135	900
Hover		48	68
endurance:			
1 hour			
cruise endurance:			
4hours			
5 hours	4,570	23	
	4,880	2	
5 hours	2,750	50	175

strikes. Current UCAV concepts envisage an aircraft which would be able to operate virtually autonomously. It will be programmed with route and target details, and conduct the mission without help from human controllers on the ground. For various reasons, however, current designs incorporate a "man in the loop," meaning that a ground controller must authorise weapons release. Some examples of UCAVs include the Boeing X-45, a concept demonstrator, developed by Boeing's Phantom Works and

the Northrop Grumman X-47A Pegasus.

The USAF has shifted its UCAV program from medium-range tactical strike aircraft to long-range strategic bombers. The technology of the Long Range Strike programme is based on the Lockheed Martin Polecat demonstrator. The French Air Force is also expected to start fielding the Dassault Neuron by 2010. The Israeli Air Force plans to procure a large long-range UCAV that resembles a fighter-jet. The Israeli UCAV, named Eitan, sports a wingspan

of 26 meters and a take-off weight of four tons. The state-owned Israel Aircraft Industries has developed the Eitan, which would be a multi-purpose UCAV with automatic take-off and landing. It will be able to locate and destroy mobile ballistic missile launchers in reconnaissance and attack missions.

Modern US Endurance UAVs

The Predator

The US dominates the Endurance UAV field. Endurance UAVs are now an important military asset. The first endurance UAV to be widely used in combat was the General Atomics "RQ-1 Predator", a derivative of the Gnat 750. The Predator can carry a laser target designator, and has provisions for stores pylons under the wings. The Predator is fitted with a number of data link antennas, for control or data download via a direct RF or satellite link. The UAV can provide real-time data to other platforms, such as the J-STARS battlefield surveillance aircraft or submarines. The Predator is designed to keep watch over a battlefield area for a long period of time. It can monitor a 185x185 kilometer grid. The Predator is almost completely silent, and is invisible to the eye at a range of about 4 kilometers. Cost for an early production Predator was about US \$3.2 million.

The Warrior

The usefulness of Predator drove the US Army, in the summer of 2005 to award a contract to General Atomics for the Warrior, a Predator with a heavy fuel (diesel/jet fuel) engine, a slightly increased wingspan, and increased system redundancy. The Warrior will carry surveillance, communications relay, and strike payloads and will feature a Tactical Common Data Link (TCDL) along with its satellite communication link. Operational endurance will be up to 36 hours.

The Global Hawk

The Northrop Grumman Global Hawk is not particularly stealthy, but it has sophisticated long-range sensors to allow it to operate outside of hostile air defences, and can survey as much as 100,000 square kilometers of terrain a day. In comparison to the Predator, a Global Hawk can observe a 370x370 kilometer grid and stay airborne for 24 hours. A Global Hawk

Global Hawk ready to take-off



costs about US \$10 million and is powered by an Allison Rolls-Royce AE3007H turbofan engine; it carries a payload of 900 kilograms (2,000 pounds).

Sensor Craft

Northrop Grumman has conducted preliminary investigations for the USAF Research Laboratory of a follow-on HALE vehicle, known as the "Sensor Craft", which would have greater endurance and payload. Sensor Craft appears to be a purely experimental programme, but the confrontation between the US and China over the EP-3 SIGINT aircraft in the spring of 2001 helped increase interest in a new, large surveillance UAV.

Future of UAVs

The next century of flight will see the roles of future unmanned vehicles merging with those of space-based assets as technology allows them to fly higher, longer, and with more capable sensor packages. Typical capabilities of these next-generation unmanned observation vehicles will include continuous 360-degree sensor coverage flying from altitudes exceeding 60,000 feet, increased survivability gained from improved low-observable technologies, and mission duration times exceeding 40 hours per sortie. Further development of solar-electric propulsion and fuel cells may lead to mission duration times measured in weeks rather than hours. UAV technology may narrow the differences between air and space vehicles, as they begin to function more like very low-orbit, persistent satellites than like aircraft. However, unmanned vehicles will offer increased mission flexibility over space-based platforms that have their locations fixed in an orbit over the earth. ■

Israel: Leader in UAVs

The Israelis were the prime movers in establishing the battlefield UAV as a standard military weapon. Israel owes its early development of UAVs to Alvin Ellis and his colleague Yehuda Manor. Their efforts produced the first operational system called "Mastiff". It was introduced in 1975. By the early 80s, the Israeli military began to buy more Mastiffs, while IAI came up with a competitor with the appropriate name of "Scout". In June 1982, the Israelis used their UAVs innovatively to destroy all missile sites in Bekaa Valley. Israeli battlefield UAVs had proven a great success and soon came to the attention of the US military. The Mastiff and Scout remained in service with the Israeli Army until the early 1990s, when they were replaced by the Malat Searcher. The Israelis are now using the further improved Searcher II, yet another scale-up of the basic Scout design with improved endurance.

While Malat has been moving towards bigger and bigger battlefield UAVs, the company has also been exploring the lower end of the range, with an interesting aircraft known as the Eye-View. IAI sells another UAV, the Harpy, an anti-radar loitering attack drone that patrols over a battlefield, waiting for somebody to turn on a radar and then dives into it, destroying it with a blast-fragmentation warhead. The Harpy is in service with the Israeli Defence Forces, as well as Turkey, India, China, Taiwan, and the Republic of Korea. Another Israeli firm, Silver Arrow focuses on selling large UAVs, but also sells two small battlefield UAVs, including the Sniper and the Micro-V. In 2002, Silver Arrow introduced a new "high-end" tactical UAV, the Hermes 180 with an endurance of more than 10 hours. The Hermes 450 is the latest generation and most advanced UAV that supplies real time battlefield

data and meets the intelligence requirements for ground forces.

India-Israel UAV Partnership

Aero India 2005 witnessed the development of India-Israel partnership in the UAV sector. They entered into a new partnership under which Israel will help India in its development of UAVs. Under this deal, IAI will assist the state-owned Aeronautical Development Establishment (ADE) in Bangalore to develop three new UAVs: the Rustam medium-altitude long-endurance (MALE) UAV, the Pawan short-range UAV and the Gagan tactical UAV. IAI and ADE have begun preparatory work that involves testing



major subsystems on a manned aircraft. The Rustam, a 1.1 ton UAV, is being built to remain aloft for more than 24 hours with a range of up to 300 kilometres and a maximum altitude of 10,000 meters.

It will be able to use satellite links to transmit data, thereby extending its surveillance range beyond 1,000 kilometres. It will also be equipped with maritime patrol radar and electro-optic sensors from Israel, with an indigenous electronic warfare and communications system. This UAV will be used by India's three services and will not be exported. The Rustam program is likely to be completed in 48 months, during which four prototypes will be produced. Meant to equip Indian army divisions, the Pawan will be comparable in size and capabilities to Israel's Eye View, Hermes 180 and Silver Arrow drones. The 120-kilogram Pawan will have day-and-night surveillance capability, an endurance of five hours with a range of 150 kilometers. The Gagan UAV programme will feature development of an advanced version of India's Nishant UAV. The Gagan UAV will have a range of 250 kilometers and an altitude of 6,000 meters.

LARGE AIRLINERS

Brendan Gallagher UK

THE AIRBUS-BOEING DESIGN WARS ARE FAR FROM OVER AS THE WORLD'S TWO LEADING AIRCRAFT MAKERS PLOT NEW CAMPAIGNS IN SEATTLE AND TOULOUSE



The long awaited stretch of the Jumbo – Boeing's new 747-8

Boeing

THE BIG FIGHT

For most of the 20th century airliner generations were defined by increases in speed – from the early ‘draggy’ biplanes to stressed-skin monoplanes, from turboprops to swept-wing jets flying at just below the speed of sound. In the early 1970s it was believed that the next step lay in supersonics. But cost and sonic boom turned the Mach 2 Concorde into a white elephant, and the dream of a step up in speed finally died when Boeing abandoned its Sonic Cruiser in 2002.

Now – and for as long as anyone can see – the emphasis is squarely on operating aircraft that are economical but provide a more comfortable ride for passengers, with a reduced environmental impact. These are the imperatives underlying the design of the flagship projects of the world's Big Two airliner manufacturers – the Airbus A380 and the Boeing 787.

Differing/Converging Views

The giant Airbus and the medium-sized Boeing arose originally from two opposing views of how long-haul air transport would evolve over

the coming decades. The European manufacturer believed that the present international hub-and-spoke system would continue to be the norm, and that bigger and bigger aircraft will be needed to carry more passengers at a time into airports like Chicago O'Hare, London Heathrow and Tokyo Narita. Boeing's bet was on fragmentation – increasing demand for direct flights between second-ranking destinations.

The two airframers were united in their conviction that the new aircraft should be significantly more economical, clean, quiet and passenger-friendly than their predecessors. But their conflicting market analyses led them to develop two quite different aircraft – one a four-engine double-decker initially seating a nominal 555 passengers but capable of being stretched to 800 or more, the other a twin with a maximum capacity of around 300.

Present plans call for the two to enter revenue service within 12 months of each other – the A380 next autumn, the 787 in mid-2008. But in the three years since development of the Boeing type was launched, the manufacturers have quietly moderated their all-or-nothing,

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hub-versus-fragmentation views. Now Airbus is committed to taking on the 787 directly with its A350XWB, while Boeing is fighting for a slice of the very large aircraft (VLA) market with the updated 747-8 Intercontinental.

The fact that like is once again competing with like was highlighted at the beginning of this year, when British Airways announced it was evaluating the A350XWB against a mix of 787s and current-generation 777-300ERs to replace its long-haul twinjets, and the A380 against the 747-8 to meet its VLA requirement.

The BA selection neatly sums up the broad choices now confronting the world's leading international airlines. At the top end the A380 offers a nominal 555 seats, though most of the early operators plan to settle at around 500 and use the extra space to attract premium passengers. The 747-8, embodying the 787's flight-deck and cabin technology and fuel-saving new engines, is currently sized at 467 seats but could come out closer to 500.

On that basis there seems little to choose between the two big jets. Look again, though, and it is clear that the 747-8 is on the limits of its stretchability while the A380 hasn't even got started yet. The first stretch version to be

defined, the A380-900, would seat around 650 passengers in three classes, and over 800 in a high-density layout. If the airlines ever decide they need that much capacity in a single airframe, the A380 will be in a class of its own.

With the 787, Boeing stole an early marketing march by portraying it as offering unbeatable operating economics, along with radically new internal and external styling. But as the design firmed up, the rakish nose and fin profiles of the first brochures quietly gave way to more conventional lines. At the same time, it emerged that its much trumpeted new cabin features – including a lower cabin altitude, larger windows and improved air quality for increased passenger comfort – would also be found in the A350XWB.

When it comes to the fundamental operating

A380 orders currently stand at 166 plus 49 on option, and there could be more to come before long.

economies afforded by their new engines and lighter structures, both the 787 and the A350XWB will represent a major advance on the preceding generation and it could prove hard to tell which is superior. Instead, their ultimate success in the marketplace could well be decided by other factors – the 787's five-year head start, the Airbus type's wider fuselage and ability to compete also with the larger Boeing 777.

Airbus A380

Despite a torrid recent history that has seen its production schedule slip by nearly two years, the A380 will be the first of the new quartet to carry fare-paying passengers when launch customer Singapore Airlines (SIA) finally takes delivery of its first example in October. SIA should have introduced the super-jumbo already, but 2006 was an annus horribilis (horrible year) for Airbus that saw production problems threaten the very viability of the A380 programme. The schedule first came into question in 2005, when Airbus negotiated new delivery dates with key customers, citing a slip in the flight-test programme and delays in finalising cabin configurations. SIA, for instance, agreed to receive its first aircraft in the second half of 2006 rather than the second quarter.

But the ground really began to shake last June, when Airbus said unspecified 'industrial issues' meant that production ramp-up would be postponed for another six months. At that point the company still aimed to certificate and deliver the first aircraft by end-2006, but to deliver only nine in 2007 against the previous target of 20-25. The first clue to the problem came shortly afterwards, when Airbus said it was working to eliminate bottlenecks in the installation of the 300km of wiring and 100,000 electrical links to be found on each aircraft.

From then on things went from bad to much worse. Another delay warning came in September, and the following month the sheer scale of the catastrophe was revealed. Despite the fact that fully 15 airframes were structurally complete and work had begun on a further 21,

Jet Airways could be one of the immediate buyers of Boeing 787 Dreamliner.



Boeing



Billypix/Flight Daily News



The A380, now certificated but delivery to first customer Singapore Airlines is delayed

only the single SIA aircraft would be delivered in 2007, to be followed by 13 to SIA, Qantas and Emirates in 2008. Industrial ramp-up would not be complete until 2010, and the estimated cost to Airbus was put at Euro 2.8 billion (US \$3.7 billion) over 2006-10.

Still the bad news rolled in. Prime customer Emirates, with 43 A380s on order, declared ominously that it was reviewing its options. Virgin Atlantic deferred first deliveries of its six aircraft from 2009 to 2013, and FedEx Express cancelled its order for ten A380-800F freighters. And a crestfallen Airbus announced that it would now have to sell 420 A380s worth a massive US \$78 billion, compared with its estimate of 270 a year earlier, before breaking even on the programme.

It wasn't all misery for the A380, however. The smooth and impressive last stages of flight testing that led to FAA and EASA certification in December inspired SIA and Qantas to express their confidence in the technical design. Singapore Airlines went on to confirm its previously announced intention to increase its order from ten to 19 aircraft, while Qantas placed a brand new order for another eight, bringing its total to 20.

A380 orders currently stand at 166 plus 49

on option, and there could be more to come before long. At the beginning of the year Airbus chief executive Louis Gallois said he expected further orders from existing customers. Lufthansa and Thai Airways International are seen as the likeliest candidates.

Boeing 787

Compared with Airbus' beleaguered behemoth, the Boeing 787 seems to be cruising serenely towards first flight and service introduction. The latest all-new design from the Seattle Company, the 787 was launched in April 2004 after a long period of indecision during which Boeing seemed to have lost its way as a builder of air transport aircraft.

In the 1990s and early years of this century several abortive attempts to define an A380 competitor under the 747X label were followed by the Mach 0.96-0.98 Sonic Cruiser, which proved too exotic for the airlines to swallow. But now the 787, originally labelled '7E7' to signal that it would set a new standard for operating efficiency, bears all the hallmarks of a runaway success.

At the turn of the year Boeing announced a ten-aircraft order from Indian carrier Jet Airways that brought the total to date to 471, including

157 in the previous 12 months and worth more than US \$70 billion at current list prices. Boeing says this tally makes the 787 launch the most successful ever for a commercial aircraft. But there are signs that it won't necessarily be all plain sailing over the next couple of years.

One of the keys to the 787's fuel economy is a light structure featuring a high proportion of composite materials. Last summer Boeing confirmed that a sample 787 fuselage barrel had failed in tests when the composite skin showed signs of bubbling. The company blamed a new manufacturing method and pledged to fully master composites, tooling and production processes before starting production.

There is also the question of hitting weight targets. At the end of the year Boeing admitted that the aircraft was about 2% overweight, equal to 5,000lb of extra bulk, and upped its research and development budget by over US \$200 million to cope with what chief executive Jim McNerney described as 'a dogged issue'. A third area of concern was the supply chain, with a number of system vendors behind schedule and under pressure to implement recovery plans.

Even so, Boeing continues to radiate confidence that the 787 will take to the air in the second half of this year and enter commercial service around 12 months later. If that time table holds, it will be a double-milestone year for the company, which is aiming for a 747-8 first flight as early as the end of 2008.

Boeing 747-8

First deliveries of the 747-8F freighter are set for the second half of 2009, while launch customer Lufthansa will get its first Intercontinental passenger aircraft the following year. With orders now standing at 49 freighters and 24 Intercontinentals, the 747-8 programme has breathed new life into the original jumbo jet, whose production days seemed to be numbered as recently as mid-2005.

Airbus A350XWB

Last of the four new types into service will be the A350XWB. If Boeing's plans for the 787 and

747-8 look ambitious, then Airbus faces a Herculean task in bringing its competing products to market. Not only does it have to slash the Gordian knot of A380 production but in the A350XWB it must also design, develop, build and introduce a brand new aircraft in time to win a worthwhile share of the long-range twin-jet market.

At the beginning of last year the A350 seemed to be well within the compass of an Airbus that was still riding high. To be based on a combination of the A330 fuselage cross-section with new engines, a modified wing and a comparatively modest proportion of new structural materials, it looked straightforward enough, amounting to not much more than a mid-life upgrade of the company's existing long-range twin.

But some of Airbus' key customers – among them Singapore Airlines and influential lessors ILFC and GECAS – thought otherwise, dismissing the scheme as a 'band-aid' response to the 787 and calling for an all-new design that would be competitive in the long term. Airbus listened, gritted its teeth and last summer announced the A350XWB.

Designed to confront not only the 787 but also the larger and increasingly successful

777, the A350XWB is a new aircraft and major advance on the previous concept. It features a wider, completely new fuselage, a larger wing, a choice of more powerful engines – a new version of the Rolls-Royce Trent, plus the General Electric GEnx, which will also power the 787 – and a structure that is more than 50% composite.

After some anxious times during which it had to watch as much of the original A350 order book showed signs of evaporating, Airbus is now reaping its reward for doing the right thing.

In October, China Aviation Supplies Import and Export Group Corporation signed a letter of intent covering 20 XWBs. Formal industrial

If Boeing's plans for the 787 and 747-8 look ambitious, then Airbus faces a Herculean task in bringing its competing products to market.

launch of the programme came at the beginning of December, along with confirmation of a Finnair order for nine aircraft. At the beginning of this year, Singapore Airlines said it planned soon to confirm an order for 20, plus 20 on option, and shortly afterwards US lessor Pegasus Aviation Finance signed for two.

Many of the pre-redesign customers – they include Air Europa (10), US Airways (20), Qatar Airways (60), GECAS (10) and ILFC (6) – have still to reconfirm. But at least Airbus has taken its first steps up one of the two mountains it must scale before it can once again challenge Boeing across the board.

Conclusion

How effectively it will do that will probably not be clear until 2010, when the A380 should at last have reached full production tempo and A350XWB development should be in full swing towards service entry in 2013. But anyone who believes the Airbus-Boeing design wars are now over for the next decade or two needs to think again. Though the gun smoke is beginning to drift away from the long-range twin and VLA battlefields, new campaigns are being plotted in Seattle and Toulouse.

At stake is the enormous market for all-new aircraft to succeed the A320 family and 737NG short/medium-haul narrow bodies. Both manufacturers say publicly that their current products have years of development life left in them yet. But behind the scenes they are quietly aggregating technologies, looking to the day when an all-new package will make sense. Boeing, which last year formed a 737 replacement study team, says that won't be until 2012 at the earliest. Airbus owns up to studying composites for narrow body fuselages but insists that it has no plans for an A320 successor.

Whatever the truth of these claims, one thing seems certain, the moment Boeing makes a move on a 737 follow-on, the men from Toulouse will pull the trigger on a programme of their own. Caught napping by the 787, they won't make the same mistake twice. ■



At the third time of asking, Airbus is chasing the market with the latest version of its A350 concept

BUSINESS AVIATION

The newly certificated Hawker 4000 with its all-composite fuselage is leading the way for business aircraft design going forward. Inset: Jim Schuster—excited by the prospects for business aviation in India



Raytheon

Alan Peaford UK

INDIA AND ITS NEIGHBOURS HOLD THE KEY TO THE RAPIDLY GROWING BUSINESS AVIATION MARKET THAT IS TAKING THE WORLD BY STORM

EXCITING TIMES

Jim Schuster is the architect of one of the biggest deals in the business aviation sector. As chairman of Raytheon Aircraft Company (RAC) he was instrumental in finding and working with prospective owners who would move one of the great brands in the sector into new territory. The result was the US \$3.3 billion deal that will see Schuster becoming chief executive of the new Hawker Beechcraft Corporation under the ownership of global finance house Goldman Sachs and Canadian investment company Onex Partners.

The sale should finally be closed by the middle of this year and Schuster is confident that the strategy that has seen RAC achieve all of its financial targets over the past five years will now see further growth – thanks primarily to

the new markets of India and the Middle East. “We’re going to have experienced partners that are really committed to the growth and success of this business” Schuster said. “They (our partners) are investing in all of the RAC people and not just buying a business. They are investing in a team they have confidence in, and the timing couldn’t be better,” he said. He added: “Markets both in North America and the rest of the world are as strong as, or even stronger than they have ever been. The markets in the Middle East and India are particularly exciting. We look at those markets as areas we are committed to and will expand our presence in. This new ownership structure is not the end of a process but the beginning. Our success will be in terms of growth. If we grow then we create opportunities.”

Looking East

Schuster explained just why so many of the primarily US-based manufacturers are turning their attentions eastwards. "If you look at the growth of the international markets, it is not inconceivable that we will avoid the dramatic downturns we've seen in the past since these markets operate differently," he said. He pointed out: "Look at percentage of sales from OEMs outside of the traditional North American market. We are at about 40% now but across the industry you'll see a balance of 50%. That changes things. The general aviation industry is not then so dependent on one economy or set of conditions."

The quid pro quo as far as the developing markets are concerned will be greater presence in the market place. Encouraging US manufacturers to create facilities away from the North American continent has proved to be nigh on impossible in the past, but while committing to remain in Wichita, Schuster sees possibilities ahead. "A major part of investment is in our people," he emphasised. "You can build a building and buy equipment to put in it, but putting together the culture, talent and commitment that we have here is not something you can easily put together," he explained. Laying down the mantra for competitiveness, he said, "In order to remain cost competitive we will continue to evaluate what we make where we make it, what we buy where we buy it. And we'll keep tweaking that to make certain we keep cost structure in line." He added: "We are all pretty much in the same boat throughout the industry. With growth comes some stresses and strains on resources whether it is the supply chain, or engineers or skilled folk who build airplanes. All OEMs are affected in one or all of those ways; these are realities that do make you distribute the work. Move around the work where there are ample supplies around the world. Every day we are looking for people with different skill sets – our competitors are doing the same."

New Horizons

The Hawker Beechcraft Corporation will be looking for investment from its new owners to increase the product line – which already

All business aircraft manufacturers see India as vital to their plans and will be at the Aero India 2007 to make their respective cases.

includes the world's best selling business jet the Hawker 800. The introduction of new models has proved a successful driver for growth for RAC's biggest competitor Cessna who have produced more airplanes than any other manufacturer in the world. "Growth drivers are consistent priorities for us," said Schuster. Elaborating, he said: "We have six clear drivers. Being cost competitive remains very important. We need to drive the cost pressure particularly in the international market place with new competitors entering the market.

We need to deliver highest quality products in the industry and put a stronger emphasis on support and customer services. We have made wonderful progress in this area over the last three years. We know so because our customers are telling us so." Schuster stressed the need to introduce new products into the market place with great reliability, on time and on budget. At the same time, the company had to expand its international footprint in terms of landed presence in important international markets.

RAC has recently seen the Hawker 4000 certificated, ten years after it was first announced. The aircraft features an all-composite fuselage and has utilised the latest Honeywell Primus Epic avionics. The aircraft is the first of its kind to use the composite technology and the weight savings have led to a much larger cabin yet still having 3,341nm (6,188km) range. Composites also feature on the entry-level jet the Beechcraft Premier1A which Schuster's team sees as being a mainstay for the burgeoning charter operators throughout India.

The other manufacturers also see India as vital to their plans and will be at Aero India in

The interior of the Gulfstream G550, the chance to fly above the weather and the airline traffic to the city of your choice.



Gulfstream Inc



Bangalore to make their respective cases. According to Judith Moreton, MD of Bombardier's Skyjet International, the growth in the market will be evolutionary rather than revolutionary. "There has to be a lot of work done on infrastructure and agreements between countries in the region," she said. As well as producing business jets that range from the Learjet light jet aircraft right through to the ultra long range Global Express XRS that can fly some 6,500nm, Bombardier has invested heavily in its charter operation business. Skyjet offers a jet card system that allows customers to buy the use of as little of 25 hours of a business jet a year. Currently working in the US, the Middle East and Europe, the concept is rolling out around the world. "The use of these cards stimulates interest in business aviation," Moreton says. "People begin by ad-hoc charter, then get the cards for more frequent use and then opt for either fractional or full-ownership of a business aircraft."

Bombardier has recently introduced the Learjet 60XR which features the new Pratt & Whitney Canada PW305A engines and the Rockwell Collins ProLine 21 avionics. It cruises at Mach 0.81 at 51,000 feet and has a range of 2,450nm (4,540km). "Like the Learjet 45XR, we can see a lot of interest from charter operators and at Skyjet we know how much our customers are looking forward to using this aircraft" Moreton said.

Gulfstream, whose name is synonymous with luxury in the business aviation market, sees the whole Asian market as a stronghold. With some 50% of all business jets operating in the Middle East for example, the Savannah based company recognises the need to increase awareness of the benefits of business aviation so that VIPs and high worth individuals see the advantages as more than just status. "A business jet gives you great flexibility with the ability to fly direct between cities. It is important to match the range capability of the jet to your key city pair requirements. Our fleet provides ranges from 2,950 nm to 6,750 nm," said Robert Baugniet, Gulfstream's director of corporate communications. Listing the advantages of business jets, he said: "The speed of the

aircraft equates to less flying time. The ability to fly direct between city pairs and high cruise speeds (typically 530 mph – 560 mph) can lead to significant time savings – 30 to 60 minutes on long trips. Many airliners typically fly 50 mph slower. On top of this the high initial and final cruise altitudes of business jets provides many advantages to the passengers, including the ability to fly above the weather and the ability to fly above slower airline traffic."

Gulfstream's flagship is the G550 which can fly from New York to Tokyo non-stop in 14.5 hours. The company is adding significant upgrades including synthetic vision for the pilots that will allow for even safer operation in areas of high terrain or poor visibility.

Cessna is growing its product line. Already in the last six months the company has announced two new aircraft – a Citation CJ4 and the upgraded Citation XLS+ – and is carrying out a market study to look at a large cabin aircraft

Business jets provide many advantages to the passengers, including the ability to fly above the weather and the ability to fly above slower airline traffic.



which will feature in the super-mid-size category with a cabin, the manufacturer suggests, that could rival the G550 for space.

The biggest competition is at the very light end of the market where Cessna was first to market with the Citation Mustang which the manufacturers describe as an entry-level business jet. This aircraft will carry four passengers and has a range of 1,150nm (2,130km). At US \$2.54 million the aircraft looks good value, but the market has been shaken up with the introduction of the Eclipse 500 and the Adam Aircraft 700. Both are ultra light jets with the Eclipse having its first delivery on the last day of 2006 and a sale price of just over US \$1.5 million.

Eclipse 500 is the brainchild of former Microsoft executive Vern Raburn who was backed by his former partner Bill Gates in developing this four seater. With a range of 1,125nm (2,084km) Raburn believes this concept will change the world of business jet travel. Already air taxi operators in the US are queuing up to take delivery and with the ability to operate from paved, grass or dirt runways, Raburn is adamant that the aircraft will be popular in the developing business aviation world.

But it is at the luxury end of the market that the business aviation world will be focusing its attention this year. The French manufacturer Dassault is set to deliver its latest gem, the Dassault Falcon 7X. First deliveries should begin in April. The three-engine Falcon has fly-by-wire controls, a whole new avionics suite (Falcon EASy) and will fly at a remarkable Mach 0.92 – way faster than any commercial aircraft and only marginally slower than Cessna's Citation X – for nearly 6,000nm (11,019km). With its ability to reach markets around the world with virtually a single hop, the French company sees Asia as a vital part of its sales strategy for the top corporations, governments and high worth individuals.

The last word goes to Raytheon's Schuster. "These are exciting times for all of us – we are all going into this with a willingness to remain for the long haul. We are excited by the fact that the prospects for a strong market to continue remain very good right now." ■



Raytheon

AH-1 Super Cobra of US Marine is fitted with HMOSP.

Lt General (Retd) Naresh Chand

MILITARY MEAN MACHINES

THE THRUST FOR MILITARY HELICOPTER UPGRADES SHOULD BE BETTER DAY AND NIGHT CAPABILITY, SITUATIONAL AWARENESS AND ENHANCED SURVIVABILITY

Military helicopters are designed and fitted with weapons and electro-optical devices to carry out reconnaissance, attack, utility and transport missions. As it is expensive to develop new helicopters for specific roles it makes economic sense to upgrade their capabilities in aeronautics, avionics and weapons periodically. This article describes some of the available capabilities and upgrades.

Europe

Eurocopter is one of leading companies in Europe. A large number of their helicopters are on the inventory of European countries – from a single multipurpose helicopter to Tiger which is an attack helicopter.

Tiger: This is a conventional helicopter with a

gunship configuration with the crew sitting in tandem. Both the cockpits have twin colour multi-function displays (MFDs). They show sensor imagery, flight and system status and a euro-grid moving map display. It is fitted with a GPS-INS navigator system with long range gyros. It has a continuous wave doppler radar for low altitude operations and a set of low speed air data probes. Several processors support the display and navigation systems. Avionic systems are linked by MIL-STD 1553B databus. A self defence suite features radar, missile and laser warning system as well as chaff flare dispenser. It also has a German multi-role version and a French escort version.

US

MH-53 J/M PaveLow III: The Sikorsky S-65 family are in military service as H-53 which is

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the largest and heaviest helicopter in American military service. It has many versions. MH-53J Pave Low III is a modified version of the HH-53 Super Jolly Green Giant whose mission is to perform low-level, long-range, undetected penetration into enemy areas by day or night and in adverse conditions. It is meant to in-filter and ex-filter special forces with stealth. To carry out its role it is fitted with three gun stations for a mix of 7.62 mm mini-guns and calibre 0.50 machine guns. It has forward looking infra-red, inertial global positioning system, doppler navigation systems, terrain following and terrain avoidance radar, and an on board computer and integrated avionics. MH-53 Pave Low IV is a J-model that has been modified with the Interactive Defensive Avionics System/Multi-Mission Advanced Tactical Terminal or IDAS/MATT.

The IDAS/MATT is a modification to the MH-53J Pave Low III (PL-III) aircraft and is now designated as PV-IV. Manufactured by Lockheed Martin, the IDAS/MATT enhanced the defensive capabilities of the Pave Low by providing instant access to the total battlefield situation through near real-time Electronic Order of Battle updates through digital connectivity and a digital map display. This modification has integrated several new avionic systems into the aircraft including a MATT receiver and a moving digital map. The heart of the system includes an integrated electronic warfare system, infra-red countermeasure controls, missile warning, radar warning and jammer inputs as well as chaff and flare countermeasures. Threat detection, evaluation and countermeasures are also provided. A colour, multifunctional, night vision compatible digital map screen is the most visible hardware in the system. The MH-53 with IDAS/MATT is claimed to be the world's most software intensive and technologically sophisticated helicopter.

Russia

MI-35 Hind Helicopter: The original version carried eight troops which was later on configured in the gunship role (Hind-D). Later

versions (M-24P and MI-35P) are also armed with anti-tank missile systems for engagement of moving armoured targets, weapon emplacements and slow moving air targets. The later upgrade packages include new avionics and thermal imager. Other upgrade packages included Denel/Kentron of SA which have eloptro infra-red sighting systems and Kentron Mocopa anti-tank missiles. IAI Tamam has HMOSP (helicopter multi mission optronic stabilised payload) with FLIR, TV and auto tracker, embedded GPS and cockpit multi function displays.

Avionics: MI-24 D is equipped with KPS-53A

The MH-53 with IDAS/MATT is claimed to be the world's most software intensive and technologically sophisticated helicopter.

EO sighting pod. The most recent MI-24V and P variant have a digitised PNK-24 avionics suite, multifunction LCD cockpit display, Geofizika Onvi night-vision goggles, along with NVG compatible cockpit lighting. They are fitted with URALS optical and mechanical plan GOES-34Z TV/FLIR sighting system and a laser range finder. Counter measures include infra-red jammers, radar warner and flare dispenser.

Israel

Tamam: a division of IAI

This company offers excellent helicopter upgrades packages which include rapid integration of observation/sighting, navigation, self defence and self-protection equipment proven in actual war conditions. Tamam's electro-optical package for MI-24 is built around 1553 digital databus. The heart of the upgrade is a single mission computer developed with IAI MLM, which is a derivative of the model used in the US Air Force T-38 upgrade programme where IAI is the main contractor. It uses HMOSP of Tamam which is a proven system. The HMOSP has two types of FLIR, one operating in the low-wavelength band and the second one functioning in the middle wavelength. Monochrome or colour CCD TV cameras are included with a laser range



MH-53 Pave Low III can infiltrate and exfiltrate Special Forces stealth.

US Air Force



finder, designator, pointer and a built in auto-tracking unit that uses centroid and edge-tracking techniques.

The cockpits are NVG compatible with both crew members having the option to use IAI's advanced NVG. Both cockpits have a single multi-function display (MFD) for TV, FLIR and targeting information in addition to a separate display unit for navigation and communication control. The HMOSP has been integrated with the Shturn V ATGM SLOC guidance system. Navigation improvements included by IAI have a GPS receiver integrated into the DISS-15D Doppler sensor and a 3D digital map display. Both the HMOSP and YAK B-12.7 gun are slaved to the pilot's line of sight through the use of a helmet-mounted sensor. It can also be slaved to HMOSP. IAI chaff/flare dispenser units and Elta radar/laser/missile warning systems have provided a self-defence capability. It is understood that the Indian Air Force has opted for IAI-Tamam upgrade package.

Elbit Systems: Elbit has achieved new safety and performance peaks with Elbit Systems' helicopter upgrades. They equip reconnaissance, transport, utility or attack helicopters with sophisticated weapons, sensors, navigations and targeting capabilities that turn them into multiple platforms for day and night missions. Some examples are Puma-330, CH-53/2000 and Black Hawk.

Puma-330: In a large scale upgrade programme, Elbit Systems have converted the Puma-330 utility platform into a fully modernised multi-role attack helicopter for the Romanian Air Force. The upgrade incorporates day/night all weather capabilities. The integrated "SOCAT" System includes: Improved navigation with an integrated Inertial Navigation System/GPS (INS/GPS); digital moving map and Cockpit interface unit for in-flight editing of navigation points.

CH-53/2000: The CH-53/2000 upgrade performed for the Israel Air Force (IAF) is designed

to meet the complex demands of combat pilots, reducing workload and allowing them to focus more on the mission. It has an enhanced avionics system.

Black Hawk: Elbit Systems enhanced Black Hawks are currently in operational service. As the Weapon Management System (WMS) supplier and weapons integrator for Sikorsky, Elbit Systems WMS has provided these systems with Armament Control System with aiming and stores management; observation and targeting system and display and sight helmet with line of sight cueing.

Conclusion

There are multiple options for helicopter upgrades in any role. The thrust has been to provide improved protection, better day and night capability, quick and in-depth situational awareness, superior navigation and targeting capability, enhanced survivability, and near stealth profile. ■



Eurocopter

Tiger-conventional helicopter with a gunship configuration.

Lt General (Retd)
Naresh Chand

MODERNISATION OF ARMY AIR DEFENCE IS LAGGING BEHIND BY AT LEAST A DECADE WITH NO IMMEDIATE SOLUTION IN SIGHT



Skyshield of Oerlikon Contraves is in the race to succeed four decades old Bofors L/70 gun.

Photographs: SP Guide Pubns

YAWNING GAP

Modernisation of Army Air Defence has been on the anvil for a long time. However, no concrete solutions are in sight. A look at the current not-to-happy scenario will prove that the problem is serious and calls for out-of-box solutions.

Gun Systems

The mainstays of the Indian Army are 40 mm L/70 and ZU-23-2 guns. But the 40 mm L/70 is four decades old and has a low rate of fire. It is manpower intensive and too heavy for a mobile role. DRDO's efforts to develop a future gun system had to be abandoned owing to tardy progress. A fresh developmental project was sanctioned a couple of years ago and an optimistic estimate is that it may fructify within a decade. At best, one can visualise a notional time-frame where the system is ready by 2015. But another five years for trials and transfer of technology takes it to 2020. If the ordnance factory has a capacity of converting two regiments per year then it may take almost

a decade to convert twenty regiments, taking the induction period to 2030. The system will have to remain current for at least three decades – up to 2060. The time-frame is mind-boggling. Such gaps in national security seem inconceivable. The crying need for India is to adopt certain innovative measures to fill the voids as well as to improve the quality of air defence.

The ZU-23-2 twin gun system is in a better situation as it has a high rate of fire of 2000 rounds per minute. But it cannot be coupled with a fire control radar. An additional glitch is its rudimentary sighting system.

Shilka is a tank based four barrelled gun system with a fire control radar; it was inducted into service during the early 70s. The gun system has a high rate of fire of 3,400 rounds per minute and will remain current for the future. However, the radar is of the valve version and the computer is analogue; thus both are outdated. The problem gets further compounded by acute shortage of spares. The main engine needs replacement, the gas tur-

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Customer Success Is Our Mission

bine based power supply solution is very costly and needs to be replaced with simpler and cost effective solutions. Addition of air conditioning and optronic sights will add to the efficiency of the system as well as the crew. Tunguska is the successor to Shilka and is an all-weather gun system with a fair weather missile system mounted on the same platform. After induction of a regiment worth of systems, there seems to have been no further progress.

Missile Systems

A large number of missile systems were inducted in the eighties and most of them are due for replacement. The scenario is as disconcerting as the guns. Kvadrat is a medium range, all-weather, mobile missile system which was inducted in the late 70s and along with Shilka, was the mainstay during the Yom Kippur War of 1973. It is now vintage and should have been replaced many years back. The quick reaction short range missile OSA-AK is more than two decades old and it is high time that the process to identify its successor is initiated. The successors to both the systems are Akash (medium range) and Trishul (short range) being developed by DRDO for almost two decades as part of the Integrated Guided Missile Programme; but the eternal wait continues. Trishul was foreclosed a few years back and Akash is way behind. Shoulder fired missile like Igla is current; but since it is in service with the Army, Navy and the Air Force, finding a common successor involves multiple agencies.

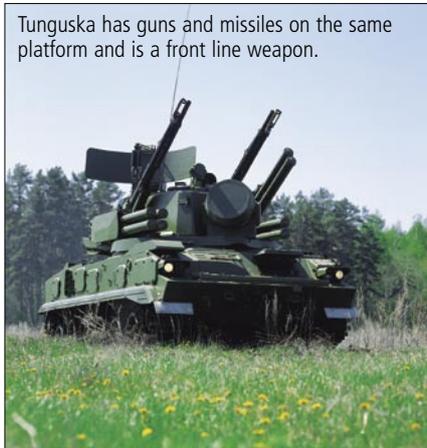
Non-Communication Electronic Warfare is another critical area where the DRDO is developing the system. But there have been major slippages in this area as well and in such a sensitive area no outside agency can be involved.

Battle Management Systems

Air defence is a system which apart from weapons includes surveillance, warning, weapon selection and clearance to fire on hostile aircraft, all in real time. Such a battle management system should have seamless integra-

In case of missiles, the picture is somewhat blurred with DRDO neither delivering nor allowing deliverance through imports.

Tunguska has guns and missiles on the same platform and is a front line weapon.



tion with the C3I of the army as well as C4I2 of the nation.

Possible solutions

The most cost effective strategy for changing a large inventory includes:

- Maintain current systems as long as possible or till replaced.
- Upgrade systems wherever possible in order to improve their effectiveness.
- Introduce new systems developed by DRDO and if they are delayed for some reason, opt for 'buy and make' as an interim solution.
- Finally, replace the complete inventory with DRDO developed systems, and if that does not seem likely then make the 'interim solution' as the final solution.

Gun Systems

Such a strategy is being followed for L/70, ZU-23-Twin and Shilka as far as the upgrades are

concerned. The development of a gun system, by DRDO, has been foreclosed twice in the last two decades. Technology options for gun systems have almost reached a plateau except for optronic sights such as a combination of laser range finder, day TV, thermal imager and better ammunition like proximity fused pre-fragmented (PFPF). At such a juncture, for DRDO to develop a new system ab-initio is like reinventing the wheel.

For L/70, the approach should be to upgrade a certain percentage and buy and make to fill the critical voids. There are good guns available in the market like 35 mm Skyshield of Oerlikon Contraves, which can engage very small targets.

Upgrade of ZU-23-2 twin gun is similar to L-70 and will be more effective than L-70 due to its high rate of fire. Later on the situation can be reviewed, and if feasible, both L-70 and ZU-23-2 can be replaced by a common successor. Shilka should continue, subject to successful upgrade, until replaced by Tunguska.

In case of missiles, the picture is somewhat blurred with DRDO neither delivering nor allowing deliverance through imports. Medium range missile system SAM-6 is obsolete and its maintenance is giving nightmares to army repair agencies. The system is of the 60s vintage; bulky and unwieldy. It is high time that it is retired gracefully and a successor selected. Buk-1M of Russian origin, Aster-15 and PAC-3 could be considered. Short range, quick reaction, all weather SAM-8 has almost reached retiring age. The initiative to look for its successor should start now, especially when the Trishul option is foreclosed. Tor-M1 of Russia and Spyder of Rafael could be considered. Spyder is quite an attractive proposition.

Conclusion

It is amply clear that modernisation of army air defence is lagging behind by at least a decade with no immediate solution in sight. The process of acquisition of equipment has become more complex, especially as the Defence Procurement Procedure 2006 has made things even more stringent. ■

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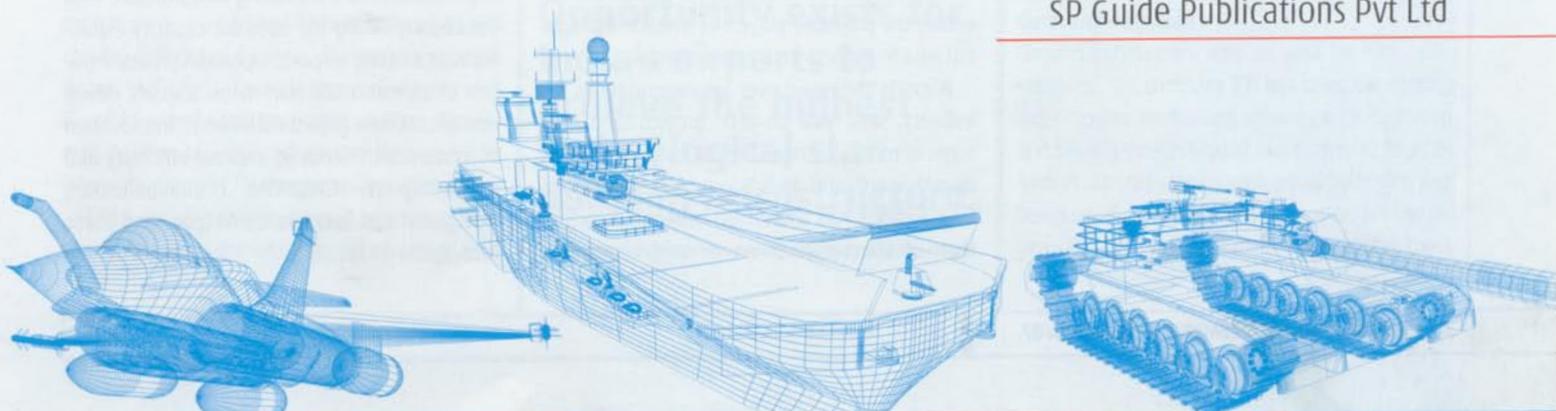
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INDIA IS PREPARING FOR A TECHNOLOGICAL REVOLUTION IN ITS AIRPORT INFRASTRUCTURE TO MATCH WORLD DEVELOPMENTS



London Heathrow's Terminal 5 which is incorporating many technological innovations including faster fuelling systems, speedy check-in and environmental advantages.

Report

EXCITING UPGRADES AND INNOVATIONS

Just across the Arabian Gulf in the busy trading port city of Dubai an American is looking closely towards India. In his mind are the 454 airports in the country some are abandoned or disused, while others are still operational and managed by the Defence Department or by the Airports Authority of India (AAI). For Bob Johnson, the chief executive of Dubai Aerospace Enterprise (DAE) each one is an opportunity for the aerospace giant to invest its billions into a sector that needs to sustain itself to enable the projected growth of aviation throughout Asia to expand to its true potential.

Airports the world over are expanding as the industry sees year-on-year growth and vast sums of money being set aside for infrastructure development and technological advancement. DAE Airports has assembled a winning consortium of companies under its umbrella and is

projecting itself as the global leader in airport development and operations. "There is a forecasted cumulative investment of more than US \$120 billion in airports in Africa, the Middle East and the Indian sub-continent by the end of 2014", Johnson says. India is very high on that priority list.

Improving Infrastructure

Increased passenger and cargo traffic requires improvements to the existing infrastructure with the country facing the need for capacity expansions at existing airports, upgrading/modernisation of its metro and non-metro airports, developments of new greenfield airports, introduction of modern technology to improve efficiency and upgrading its CNS/ATM (Communication, Navigation and Surveillance/Airspace and Traffic Management) facilities.



AAI manages 127 airports of which 86 are operational and it forecasts an investment of Rs 40,000 crore (US \$9.3 billion) for infrastructure improvements by 2010. This entails restructuring and modernisation of the major hubs at Delhi, Mumbai and Chennai. The total development plan also outlines plans for new terminal buildings at seven airports, new runways at Mangalore and Visakhapatnam, strengthening and extensions of existing runways at 14 airports and construction of taxiways and parking stands at 26 airports.

The opportunity exists for India's airports to achieve the highest technological standards in infrastructure currently being rolled out around the world, matching the developments of the kind being outlined for Frankfurt (Main) airport in Germany. Frankfurt is Europe's second busiest airport and is Germany's main hub. Fraport AG owners and operators of Frankfurt Main form part of the private consortium with GMR Group, MAPL and IDF who have taken a 74% equity share in Delhi airport.

It has many innovations in the pipeline including ETNA (Electronic Taxiway Navigation Array), a taxi and control system that focuses on taxiway management processes. Continuously growing traffic volumes at airports place higher demands on safe and efficient handling of taxiing traffic, especially in poor visibility conditions. ETNA was brought to life to develop a navigation and control system for airport vehicles that routinely operate on runways and taxiways, such as fire vehicles and fuel bowzers.

The underlying principle utilises an on-board display in the vehicle, whose position is detected with the help of D-GPS (differential satellite navigation) and various other sensors. This information is displayed in the vehicle and passed onto a central server via wireless-LAN or radio so that it can be distributed further. The taxiway control system SMGCS (Surface Movement Guidance and Control System) fitted to aircraft, delivers the aircraft position to ETNA, which can then pass the information to all ETNA-equipped vehicles.

ETNA helps prevent runway incursions and vehicle collisions through the use of optical and

audio warning signals in the vehicle. In addition to the increased physical safety of the vehicles, there is a substantial reduction in response time because of situational displays and precise control of emergency vehicles and the integration of existing and future on-board applications. ETNA is a universal platform for vehicle applications and is simple to adapt to operational builds as it is a modular system. It has been in use since 2001 with the collaboration of Honeywell and Darmstadt Technical University.

Capacity and Environmental Issues

Capacity is an issue, even at Frankfurt. Fraport is utilising several approaches to increase movement capacity. Among them is the addition of a fourth runway which has a centreline separation from the existing runways of approximately 4,620 ft (1,400 m) and allows simultaneous use. The runway should be in service by 2009. With a requirement to increase capacity as soon as possible, Frankfurt is developing a Precision Approach Monitor (PAM).



Common use self service kiosks will be a familiar site in the future airports.

Opportunity exists for India's airports to achieve the highest technological standards in infrastructure.

PAM aims to allow capacity increase by reducing the diagonal separation required by radar of 2.5nm between two aircraft by utilising a multilateration system. Multilateration uses the signals of on-board Mode-S transponders. By measuring and comparing the time taken by incoming Mode-S signals to reach the five sensors distributed within a radius of up to 45 km around the airport, the position of an aircraft can be identified. Apart from fixing the position of an aircraft, multilateration permits their reliable identification. The greatest advantage versus conventional radar systems, however, is the high refresh rate of once per second. The system is relatively inexpensive and places only minor burdens on existing radar frequencies.

Issues over the environment with regard to noise and pollution surround all plans for new airports. The airport authorities are developing systems and processes for noise reduction and pollution caused by passenger flow to and from the airport. Emirates Airlines' new terminal at Dubai International Airport Terminal 3 solved some of that by building a lot of the terminal underground. Located beneath the taxiway area the terminal incorporates an innovative design that promotes simplified, easy passenger flow (inbound and outbound) and decreases walking distances. The design of the terminal by Aeroports de Paris is in the shape of an airplane wing and is a kilometre long. Terminal 3's features include a multi-level underground structure measuring 300m x 350m, first class lounges and dedicated counters, restaurants, 180 check-in counters and 2,600 underground parking spaces. The departures and arrivals halls within the terminal will be located 10 m below the apron and taxiways.

Ground Vehicles

Ground vehicles are also an area for new technologies. Oil company BP has been developing technologies for fuelling vehicles with hydrogen and testing their everyday practicality. At Munich Airport robots fuel cars with liquid hydrogen and buses are fuelled manually with gaseous hydrogen. The oil company sees hydrogen as most

promising for three main reasons. First, there is a large potential of renewable primary energy for hydrogen production. Second, there is a high potential for CO2 reductions. Third, hydrogen can be used in both internal combustion and fuel-cell engines.

BP has been involved with several major airport designs. Air BP has been involved in airport design at London's Heathrow since 1960 and this experience has already paid dividends in the design of the fuel facilities at the new Guangzhou Airport in China, where Air BP provided engineering expertise. The oil company has developed the underground fuel distribution system for Heathrow's Terminal 5 where Boeing 747s will be able to re-fuel at 7,500 litres a minute, while the new Airbus A380 will fill up at 8,000 litres a minute.

Airport IT Systems

Inside the terminal buildings there are many other developments. Airport IT systems are a large focus for development and upgrades. The airport industry ploughed around US \$3 billion into IT and telecommunications in 2006. Investments are expected to be even higher this year.

On the back of managed networks, airports the world over are already offering a host of technologies. Voice over internet protocol (VoIP) is becoming more readily available. Web services for passengers are already being provided by 70% of airports. Although only 7% of airports provide web check-in for common-use kiosks, this will rise to 59% within two years. Wireless local area networking (WiFi) for tenant or operational use has been implemented by 71% of airports, with another 23% due on board in the next two years; and 57% have implemented digital land mobile radio or trunk radio, rising to 83% by the end of 2008.

Technologies yet to arrive are mobile commerce for purchase at the airport and mobile passenger check-in, as well as WiMax, the next-generation WiFi. Uptake of technology is clearly being driven by the operational needs of customers. New aircraft innovations such as Boeing's 787 will run updates when it arrives at

Airline Business



Aircraft Wake Safety Management AWSM are the outside sensors and the workstations that will give departing and arriving aircraft better avoidance of another aircraft's wake vortex.

The airport industry ploughed around US \$3 billion into IT and telecommunications in 2006. Investments are expected to be even higher this year.

an airport – and can have its systems updated via a WiFi network.

Common-use self-service kiosks are increasing in presence – London Heathrow's Terminal 5 will house the British Airways operation which is due to open mid-2008 and will feature 96 self-service kiosks and fast bag drops with a selection of classic check-in desks for those that need assistance. In a world where more and more things can be done online, IT will continue to play a significant role in increasing efficiency and overall services at airports worldwide.

Other Innovations

Progress is also being made on a Lidar-based wake vortex detection system which could give air traffic controllers the ability to increase airport capacity by decreasing wake vortex-driven separations. It is a laser-acoustic and pulsed Lidar (laser radar) based system dubbed AWSM – Aircraft Wake Safety Management – and is being developed by NASA, the US Department of Transport and Flight Safety Technology (FST). The system is designed to advise air traffic controllers when it is safe to use minimum traffic separation on approaching aircraft. AWSM uses a combination of sensors, real-time weather data and predictive algorithms to test for the presence or likelihood of wake vortices at critical positions along the flight path to or from the airport. By using real-time weather input, AWSM generates vortex predictions and backs up the estimates with real-time measurements with the Lidar and a laser-acoustic sensor.

Vortices pose the biggest problems when a heavy aircraft is flying low and slow in the landing configuration. It can result in an uncontrolled roll motion when downstream aircraft cross the path of the rotating airflow before it dissipates, descends or drifts downwind.

The two technologies are complementary: the Lidar system built by Lockheed Martin, determines turbulence by measuring laser light reflected by moving air particles. The laser-acoustic sensor built by FST is a listening device that captures the sound generated by the vortex via changes in the index of refraction of the air caused by the sound as it passes through the laser beam. This system could help reduce delays and its usefulness is likely to be amplified with the introduction of new aircraft at both ends of the spectrum.

From developments in ground security systems to protect the assets at the airports, to individual passenger checks, from ground movement and final approach control technologies through to apron, runway and taxiway design, there has never been a more exciting time for airport infrastructure. ■

Lt General (Retd)
Naresh Chand

EW HAS BECOME AN IMPORTANT COMPONENT OF MILITARY AIR OPERATIONS AND COUPLED WITH STEALTH HAS EVOLVED OVER A PERIOD OF TIME TO PROVIDE SURVIVABILITY AND EFFECTIVENESS TO AIRBORNE PLATFORMS

EW AND PROTECTION SYSTEMS

SURVIVING LETHAL FIRE

Faced with dense and lethal air defence, the modern fighter pilot needs to be equipped with warning devices to take timely evasive action. Since the advent of radar in UK and Germany in the forties, techniques have been developed to counter the radar. The first such system was chaff, code-named Window. Chaff comprised of thousands of small strands of aluminium foil which had been cut to suitable proportion of the emitted wave length of the radars. When dropped from the aircraft, chaff created false signals on hostile radars. However, modern radars equipped with digital signal processing are not easily fooled by chaff, giving rise to electronic counter measures (ECM) in which radio frequency is emitted to saturate the hostile radar with noise (noise jamming) or cause false echoes to appear (repeater jamming). On the other hand, radars have developed electronic counter

er measures (ECCM) to avoid being jammed.

However, radar is not the only threat which a modern aircraft faces in air combat. Threats also emanate from infra-red (IR) guided missiles against which a very simple counter measure is used in the form of a pyrotechnic flare tuned to emit radiation similar to the jet exhaust of a fighter. But as in the case of chaff, modern IR missiles are less likely to be fooled by pyrotechnic.

Electronic Warfare (EW)

EW has become an important component of military air operations and coupled with stealth has evolved over a period of time to provide survivability and effectiveness to airborne platforms. EW has three components: Electronic Support Measures (ESM – also called EW support), ECM (also called electronic protection) and ECCM (also called electronic attack). Radar warning receivers (RWR) coupled with suitable



EA-6B Prowler takes off from Aircraft carrier Dwight D Eisenhower

US Navy

ECM suites can provide effective ECM and ECCM. EW supported by suppression of enemy air defences (SEAD) with bombs and missiles, contributes significantly to the survivability of airborne platforms.

RWR

The basic RWR system has many antennas fitted on the aircraft and immediately identifies that the aircraft has been hit by an emission. More advanced systems cover 360 degrees around the aircraft so that the emitter is not masked from the RWR even when the aircraft is manoeuvring. This coverage is only in azimuth. It can also give the range to the emitter, recognise it by comparing its radar signature with the help of an ESM suite, using high speed digital processing techniques; it gives out the threat evaluation as 'threat', 'no threat', and 'immediate threat'. The crew then takes action to evade detection or break the lock. One of the weaknesses of the current systems is the difficulty in countering low probability of intercept enabled emissions which use various techniques to hide the emitted signal. It is understood that Marconi (now BAE Systems) has been working in this field to detect and classify such emissions.

Radar Homing and Warning Systems (RHAWs)

RHAWs is a RWR connected with the ECM suite and operates automatically. As soon as the threat is detected and analysed, the ECM suite takes action to jam the threat with a variety of modes available today. ECM emits radio energy directly at the source of the threat, either to saturate the hostile emitter or mislead it with false targets. An efficient system should be able to counter all types of radars like continuous wave, pulse and pulse doppler. An interesting system, developed by Elettronica of Italy, is called Cross Eye which uses two widely spaced emitters which generate two identical jamming beams which when aimed at an approaching missile or an aircraft, causes aiming errors. This results in misleading the hostile systems regarding the location of their target.

Towed Radar Decoy (TRD)

This system has been developed by BAE Systems and has been successfully tried on UK's Tornado and Nimrod aircraft. The unit is deployed from a pod using a 100m cable which contains a fibre optic link and a separate power distribution line. Commands can be sent through the fibre optic cable to the decoy based emitter. The TRD then produces a range of jamming techniques to counter the threat. The system deploys a unit externally with the help of a



Growler—the next-generation electronic attack aircraft, for the US Navy.

cable and can be recovered or jettisoned as required.

Laser Warning Receiver (LWR)

Many aircrafts are fitted with laser range finding systems and there are beam riding laser guided weapons. To counter such a threat, a LWR can be fitted under the nose of the aircraft which will detect and warn of any incoming laser radiation. It is learnt that such a system is fitted on Typhoon.

Missile Approach Warning Systems (MAWS)

The radar threats finally culminate into the launch of missiles on the aircraft. There thus arises a need to develop a system for warning the pilot of approaching missiles. Many air-to-air and surface-to-air missiles use IR guidance. MAWS typically use IR, ultraviolet/electro-optical or radar to detect missiles. Earlier, such systems were fitted only on helicopters and transport air-

Detection and Protection Systems

- **AN/AAR-47:** It is a MAWS system developed by Lockheed Martin. It detects IR threat and controls an automatic response for countermeasures through AN/ALE-47.
- **AN/ALR-56M:** This is an advanced RWR of Lockheed Martin, designed for speed, selectivity and sensitivity to operate in changing, high density signal environment. It is integrated with self protection suite of Spar Aerospace Limited to provide timely and accurate radar threat identification and response via communications with AN/ALE-47(V).
- **AN/AAR-54-(V):** It is developed by Northrop Grumman. It is an imaging sensor system that passively detects ultraviolet energy, tracks multiple sources and classifies each source as lethal/non-lethal missile or clutter. It can operate independently or can be integrated into a self protection suite. It is designed for use in fighters and wide bodied aircraft, helicopters and combat vehicles.
- **MAW-200:** Developed by Avitronics, it operates in the solar blind UV spectral region. When combined with a good direction finder and neural net based software, it provides very low false alarm rates. It can track at least eight targets simultaneously at a detection range of more than 5 kms.
- **ALE-39, ALQ-126, ALQ131 and ALQ184 of the US Airforce:** They are self protection jammers and will be replaced with better systems like ALQ-214 radar jammer.
- **ALQ126 radio frequency counter measures(RFCM) of the US Navy:** This will be replaced by ALQ214RFCM.
- **AN/ALQ-199:** It is a pulse Doppler MAWS, based on EL/M-2160 of Elisra and used in F-16D



craft. Now they are fitted on fighter aircrafts as well. The missile is detected by picking up radiation from the rocket motor and automatically releases flares. Another method for detection is through the IR signature of the missile plume. Special technique is used to discriminate against a non approaching radiation source. Some systems use an image sensor that passively detects ultra violet emissions. To reduce false alarm, colour discriminants are used. Specially designed state-of-art filters with purpose-built image intensifier tubes and photon-counting focal-plane array processors ensure high sensitivity and longer range. Some advance systems even use pulse doppler radar for detection.

Special self protection systems are composite systems which can carry out electro-magnetic detection, laser warning, jamming and chaff/flare dispensing.

Special Self protection Systems

These are composite systems which can carry out electro-magnetic detection, laser warning, jamming and chaff/flare dispensing. Elira of Israel has come up with an Advance Self Protection Suite (ASPS) for frontline fighters and light aircraft which includes a passive warning and situational awareness system with active jammer integrated into a complete self protection electronic warfare suite. The integrated warfare suite integrates passive subsystems with an active ECM jammer which can cope with a wide array of threats. A major breakthrough in IR MAWS is the Passive Approach Warning System (PAWS) which is a highly effective family of operationally deployed IR missile warning

devices. It offers an all-in-one concept for integrating multiple capabilities MAWS, panoramic display, collision avoidance, small arms fire warning and detection and ultra-accurate real time identification of incoming missile direction even when launched from short range. All-in-one concept manifests itself in easier adaptability, simplifying and reducing training, installation and maintenance costs. PAWS-1 is for helicopters and PAWS-2 for fighters.

EW Dedicated Aircraft

E-130H Compass Call: E-130H Compass Call is an airborne tactical weapon system using a heavily modified version of the C-130 Hercules. The system disrupts enemy command and control communications and limits adversary's coordination.

E-6B Prowler: E-6B Prowler is a long range, all weather aircraft with advanced electronic countermeasures capability with ALQ-99 on board receiver, ALQ-99 pod mounted jamming system, USQ-113 communications jamming system and HARM missile. It is manufactured by the Northrop Grumman Systems Corporation.

EF 111A Raven: EF 111A Raven is an EW aircraft and its most distinguishing features are a fin tip pod or football mounted on top of the reinforced vertical stabiliser and a narrow canoe-shaped radome mounted under the fuselage.

EA-18G: Boeing's EA-18G Growler is the US Navy's latest electronic attack aircraft which will replace the career based EA-6B Prowler in 2009. EA-18G combines the combat proven F/18-Super Hornet with state-of-art electronic warfare avionics suite. It is capable of Mach 1.8 and is capable of jamming enemy electronics and SEAD. It can also detect electronic emissions, classification and monitoring. The advance AEA system has been designed and produced by Northrop Grumman Corporation.

Another example is the self protection suite jointly developed by Lockheed Martin and SPAR Aerospace Limited which combines AN/ALR-56M (RWR), AN/ALE-47(V)Threat-adaptive Countermeasures Dispensing System(CMDS) and AN/AAR-47 (MAWS). The system is fully integrated and detects IR and radio frequency threats. It provides audio and visual warnings, and deploys countermeasures with minimal operator interaction.

SEAD

Combined with EW, SEAD has become a very powerful means for the survivability of airborne platforms. Apart from carrying out jamming, it also involves the firing of High Speed Anti-Radiation Missile (HARM). EA-6B Prowler aircraft not only carries out active radar jamming but also fires HARM. F-16CJ is primarily a SEAD aircraft which also fires HARM. Prowler's jamming capability is being improved so that they are able to take on frequency hopping radars. The US Air Forces' Air Combat Command has developed a concept called Countering Air Defence (CAD) which aims at improving SEAD capability by upgrading HARM targeting system, advanced targeting pod and miniature air launched decoy. This will enable it to launch joint direct munition attack, joint stand-off weapon and potentially other stand-off precision guided munitions against fixed and mobile enemy air defence systems. The US Air Force gives great importance to survivability: In a mission profile 20-40% could be attacking aircraft and 80-60% escorting aircraft to ensure survivability through jamming, decoys, SEAD or other means.

Conclusion

The modern attacking airborne platforms face a very hostile air defence and ground based EW environment. The development in air defence radars, guns and missiles has made this defence very lethal, covering a very large air space envelope. The cost of fighter aircraft, bombers and attack helicopters is very high. Added to this is the cost of training a pilot. In a bid to avoid casualties in air battles, nations are taking all measures to ensure survivability and success of the mission. ■

Air Marshal (Retd)
B K Pandey Bangalore

THE INDIAN AIRCRAFT INDUSTRY IS ON THE PATH TO GLOBALISATION THROUGH COLLABORATION WITH LEADING AEROSPACE COMPANIES



Photographs: SP Guide Pubns

PATH TO GLOBALISATION

From its humble beginnings in the private sector in 1940, the Indian aircraft industry has grown into a vast and diverse entity, most of it in the public sector. The main constituents of the industry are Hindustan Aeronautics Limited (HAL), a Defence Public Sector Undertaking that dominates the manufacturing and maintenance sector and the government run Defence Research and Development Organisation (DRDO) that has laboratories dedicated to research in aeronautics and other disciplines related to defence. There are a few private entrepreneurs such as Taneja Aerospace & Aviation Limited (TAAL) with the capability to manufacture small aeroplanes, as also a few establishments such as Varman Aviation and Air Works India who are engaged primarily in the overhaul of privately owned aircraft or engines. Their contribution is relatively small but useful. Apart from these, NAL, a laboratory under CSIR and BEL have made significant con-

tribution towards the growth of the Indian aircraft industry.

HAL

HAL, the flagship company of the nation which generates considerable public interest and sometimes consternation, has around 30,000 personnel manning its 19 manufacturing establishments and nine R&D centres. It was established with the objective of self-reliance in military aviation. Since its inception, HAL has designed and built 13 types of aircraft and manufactured a similar number under licence, which is no mean achievement for a developing country. The entire fleet of trainer aircraft comprising the HT-2, HPT-32, Kiran Mark I and Kiran Mark II are products of HAL. However in the operational fleet, whether fighter, transport or helicopter, top-of-the-line flying machines have either been procured from abroad at exorbitant costs or built under licence. The HF-24, the first indigenous combat aircraft project was success-

The IAF generates huge demand for aircraft, both fixed and rotary wing.

ful neither as a project nor learning experience. Those built under licence – the Gnat, MiG-21, MiG-27, Jaguar, Avro, Dornier 228, Chetak and Cheetah – have served the nation in full measure. With licensed production of the Su-30 MKI and Hawk, the IAF could be rated in the world as equipped with some of the best equipment. HAL is also moving from mere outsourcing manufacturing of components to vendors to seeking partners to undertake more complex tasks of design and development as well.

The IAF being the fourth largest in the world and the primary customer is bound to generate huge demand for aircraft, both fixed and rotary wing. A large proportion of the IAF budget is used to pay for procurement from foreign sources and even licensed production is a big drain unless there are markets abroad. The financial outlay in such projects are of staggering proportions – the Hawk deal is estimated at Rs 8,000 crore (US \$1.8 billion) and the Su-30MKI deal is a whopping Rs 25,000 crore (US \$6 billion).

Welcome changes in the industry are now visible by way of new projects, products and meaningful collaboration with global players.

Advanced Light Helicopter (ALH) Dhruv

The Dhruv, a world class machine, has made an impact at the various air shows in the country and abroad. It is a twin engine, multi-role, multi-mission helicopter in 5.5 ton class, designed and developed by HAL to meet the requirement of both military and civil operators. Incorporating a number of advanced technologies, series production of the ALH Dhruv commenced at the Helicopter Division of HAL in 2001. Around 70 Dhruvs are already in service with the defence forces. In 2007, HAL

plans to produce 18 aircraft with figures going up to 24 in 2008 and 33 in 2009. The armed version is scheduled for a 2008 launch. Meanwhile, upgrading of helicopters with Shakti engine is underway.

HJT-36 Intermediate Jet Trainer (IJT)

The IJT is being developed by HAL to replace the 35 year old fleet of HJT 16 Kiran jet trainers. It is a sub-sonic aircraft with fuel-efficient turbofan engine, advanced avionics and higher weapon load. This will help lay the foundations for transition to the Hawk AJT. For the maiden flight on March 7, 2003, the IJT was fitted with the Larzac engine from Snecma which delivers a thrust of 1,400 kg. In 2005, HAL entered into an agreement with NPO Saturn of Russia for joint development and manufacture of a 1,700 kg thrust engine designated as the AL-55 I. For a fleet strength of around 250 IJTs, HAL Koraput will manufacture 1,000 engines. So far, nearly 300 test flights have been completed and production of the first batch of 20 aircraft is being undertaken concurrently with the development programme. Certification is expected by end 2007

and induction into the IAF in 2008. HAL expects to roll out at least 20 aircraft per year.

Light Combat Aircraft (LCA)

The LCA or Tejas, developed jointly by the DRDO and HAL is the jewel in the crown of the Indian aircraft industry. The project was conceived in 1983 to replace the MiG-21 fleet. Although some preliminary work on design was carried out in the eighties, the project was finally sanctioned in 1993 and the prototype was to fly in 1996. The LCA represented a generational leap and even if the prototype was to be powered by an already available American engine the GE 404, the schedule envisaged was somewhat ambitious. Development of the Kaveri engine for the LCA by GTRE was sanctioned in the eighties. After an investment of Rs 6,000 crore (US \$1.3 billion), the LCA flown for the first time in early 2001 is yet considerable distance from operational clearance and induction into the IAF. The Kaveri project has absorbed Rs 3,000 crore (US \$650 million) so far and yet its availability is uncertain. DRDO is now seeking collaboration with a reputed global company to salvage the project.

HJT-36 Intermediate Jet Trainer is successor for HJT-16 Kiran Trainer and its certification is expected by end 2007





Once operational, the LCA will be comparable to the best in its class.

When fully developed and operationalised, the LCA will be comparable to the best in the world in its class.

The LCA is comparable to the best in the world in its class. With an array of critical technologies such as a glass cockpit, airframe of advanced carbon composites, a four channel digital fly-by-wire control system and sophisticated software, development of the LCA presented not only a formidable technological challenge but required progressive project management techniques. Given the inherent impediments before the Indian aircraft industry, it must go to their credit that a third generation combat aircraft, designed and developed within the country, has taken to the skies. The IAF ought to provide the support necessary to make early induction of the aircraft a reality. The real challenge is to produce the LCA at affordable cost as alternatives from abroad could cost Rs 300 crore

(US \$66 million) apiece.

By the end of 2006, the LCA had completed 580 test flights and eight aircraft are under Limited Series Production. The IAF has placed an order for 20 aircraft and a similar order is expected to follow. The first two squadrons will be equipped with the GE 404 engine. A conservative estimate indicates combat service entry not earlier than 2012.

New Joint Ventures

The Indian aircraft industry is on the path to globalisation through collaboration with leading world aerospace companies. HAL has signed the deal with Rosoboronexport to licence manufacture 120 RD-33 engines at Koraput for the upgraded MiG-29 fleet. This would help HAL progress to the next generation jet engines such as RD-33MK engines for the carrier based MiG-29K fleet and thrust-vectoring engines for the MiG-35 should these be procured. The government has approved a joint venture between HAL and Snecma for the manufacture of aero-engine components for domestic and export markets. HAL has also signed a ten-year deal with Pratt & Whitney for manufacturing high-precision engine components at Koraput and Bangalore.

HAL will undertake licence manufacture of the Hawk AJT.

Electronics display systems manufacturer Samtel has entered into partnership with HAL for development and manufacture of avionics display systems for domestic and global demand. This first public-private partnership in defence avionics would synergise the capabilities of the two companies to become globally competitive, paving the way to developing next-generation display systems. HAL is also in dialogue with Airbus for setting up an MRO facility at HAL airport in Bangalore.

DRDO

Established in 1958, the DRDO was to minimise import of weapon systems through indigenisation. Over the last five decades, the organisation has registered a few successes. But the organisation is yet to achieve its strategic objective. The organisation needs to conceptualise projects correctly and set realistic and attainable objectives.

Taneja Aerospace and Aviation Ltd (TAAL)

TAAL, a company under the Indian Seamless Metal Tubes Ltd of Pune, was established in 1994 with its headquarters at Bangalore and a manufacturing facility at Hosur. It is the only company in the private sector engaged in the manufacture of non-military aircraft and has its own airfield. The aim of the company was to create a nucleus for the development of an aircraft manufacturing facility outside the public sector to boost general aviation in the country. Since its inception, the company has diversified its activities into several areas related to the aeronautical industry. Currently, TAAL is in the process of setting up an MRO facility for commercial aircraft and acquiring state-of-the-art capability to manufacture aero-structures, machined components and composites. At present, the company is engaged in the production of the all composite Hansa trainer aircraft developed by NAL and the Thorp T-211 all metal two-seat sports aircraft. ■

CIVIL

AirAsia awards fifth contract to ST Engineering's aerospace arm



Singapore Technologies Engineering Ltd (ST Engineering) has revealed that ST Aerospace Supplies, the wholly owned subsidiary of Singapore Technologies Aerospace Ltd (ST Aerospace), has been awarded an aircraft components Maintenance-By-the-Hour contract from AirAsia for its new fleet of A320 aircraft. The US \$130 million contract involves components maintenance support over 10 years for 130 Airbus A320 aircraft from AirAsia's fleet. ST Aerospace is the aerospace arm of ST Engineering. This latest contract adds to ST Aerospace's current airframe, components and engines support for AirAsia's Boeing 737 fleet. The four earlier contracts, dating from 2002 to 2004, total about US \$133 million.

Boeing sets records for airplane orders in 2006

The Boeing Company recorded 1,044 net commercial airplane orders during 2006, and for the second year in a row set a Boeing record for total orders in a single year. The 2006 total surpasses the previous Boeing record of 1,002 net orders in 2005. Gross orders in 2006, which exclude cancellations and conversions, totalled 1,050. Boeing recorded 1,029 gross orders in 2005. For the second consecutive year, the 737 programme achieved a record with net orders of 729 airplanes. The previous record total for the 737 programme was 569 in 2005. Boeing also had a strong year across the board in twin-aisle commercial airplanes: 157 orders for the 787

Dreamliner programme, 76 orders for 777s, 10 orders for 767s, and 72 orders for 747s. This is the highest total for the 747 programme since 1990 and fifth highest in the history of the programme.

Airbus' share of civil airliner market slips to 43%

European airframer Airbus has, as expected, failed to repeat its recent successes in its annual battle with Boeing, having secured net orders for 790 aircraft in 2006, against 1,044 for its US rival – giving Airbus a market share of 43%. The manufacturer gained gross orders for 824 aircraft. It is also claiming 434 deliveries with a combined value of Euros 26 billion (US \$33.5 billion). Boeing delivered 398 aircraft. The European firm struggled against Boeing during

Privatise India's non-metro airports

Small cities are slowly but steadily becoming nerve centres of economic growth in India. This is true for the aviation sector as well. Aviation has leapfrogged in recent years with double-digit growth rates. Of course, international airports like Delhi and Mumbai have already been drawing considerable number of incremental passengers. The big story could, however, be that non-metro airports in cities such as Amritsar, Nagpur and Ahmedabad will be in the thick of action in the coming years. There is an urgent need to modernise the non-metro airports to enhance overall connectivity in the country, and to take the aviation sector to the next level of growth. The civil aviation ministry has drawn up plans to modernise 35 non-metro airports. The modernisation plan consists of developing the 'air-side' and the city-side of these airports. The total cost for modernisation of these airports is expected to be around Rs 7,000 crore (US \$1.6 billion) out of which Rs 1,500 crore (US \$350 million) will be spent on city-side development. The development of the 35 non-metro airports across the country is likely to be completed by the year 2010-11. The government has already started development of air-side of 12 non-metro airports.

the first half of last year but made up ground in the second half, although this was largely due to strong Airbus A320-family sales. Airbus has been relatively weak in the wide body market owing to the winding-down of A300 production, poor sales of the A340, and last year's uncertainties over the A380 and A350 programmes. EADS, Airbus' parent company has issued a warning that Airbus would make a loss this year owing to one-off payments related to customer settlements, charges over the A380 project, and the company's new 'Power8' efficiency scheme.

GE to acquire Smiths Aerospace

General Electric Company announced on January 15, 2007 that it had agreed to purchase Smiths Aerospace, a UK-based supplier of integrated systems for aircraft manufacturers and components for engine builders, for US \$4.8 billion in cash. The deal is subject to approval by Smiths Group shareowners as well as customary regulatory reviews. The acquisition will broaden GE's offerings for aviation customers by adding Smiths innovative flight management systems, electrical power management, mechanical actuation systems and airborne platform computing systems to GE Aviation's commercial and military aircraft engines and related services.

MILITARY

India stays Israel's single largest arms customer

Buoyed by Indian defence procurement worth US \$1.5 billion, the Israeli defence industries have recorded all time high sales figures in 2006. Chief of the Air Staff, Air Chief Marshal S P Tyagi and Navy vice-chief Vice Admiral Venkat Bharathan, among others, visited Israel in 2006 to re-affirm the strong ties. Joint R&D projects for more advanced radars, long endurance and high altitude UAVs, electronic warfare systems, third generation night fighting capabilities and such other areas are being explored for cooperation.

Israel Aerospace Industries signed US \$4.088 billion in new contracts in 2006

Israel Aerospace Industries (IAI) signed new con-

tracts worth US \$4.088 billion in 2006, compared to US \$3.4 billion in 2005, an increase of 22%. This marks the first time in IAI's history that the company has exceeded US \$4 billion in new orders in a one year period. Israel Aerospace Industries, Ltd. (IAI), formerly known as Israel Aircraft Industries, is Israel's largest industrial exporter and a globally recognised leader for the defence and commercial markets. IAI provides unique and cost-effective technological solutions for a broad spectrum of needs in space, air, land, sea and homeland defence.

Enhanced Fire Scout makes flight debut

The US Navy's MQ-8B Fire Scout unmanned aerial vehicle (UAV) made its first flight in December 2006 at the Webster Field annex of Patuxent River Naval Air Station in St. Inigoes, Md. The Navy's vertical takeoff and landing tactical UAV (VTUAV) system was originally dubbed the RQ-8A, but during the summer of 2005, was re-designated to the MQ-8B to reflect the Fire Scout's evolution toward an increased, multi-functional role. The test events marked the first flight of the enhanced variant.

F-35 achieves flawless second flight, demonstrates performance capabilities



The Lockheed Martin F-35 Lightning II has achieved another successful test flight from the company's Fort Worth, Texas, facility. "With this successful flight and its broad array of test points, F-35 flight test has really begun," said Dan Crowley, Lockheed Martin executive vice president and F-35 programme general manager. "The ease of starting and flying this aircraft is a reflection of the quality of the team who designed and built it." The F-35 is a supersonic, multi-role, 5th Generation stealth fighter designed to replace a wide range of existing aircraft, including AV-8B

F-18s, F-16s to light up Bangalore skies



A 'sales and marketing dogfight' between American fighter jets F-18 Super Hornets and the much-ballyhooed F-16s will be just one of the star attractions in the Aero India 2007, which will be held in Bangalore from February 7-11, 2007. Both Boeing, which makes the F-18, and Lockheed Martin, which manufactures the F-16, are flying down their machines and men for the Bangalore show, the first time that Americans are turning up in strength after the Aero India began in 1996. Besides two F-18 Super Hornets, Boeing will also be sending a giant C-17 transport aircraft and Chinook heavy-lift helicopters for the show. The American jets will have to contend with three other international competitors who are lining up to bid for the 126-aircraft deal that the Indian Air Force is expected to call for shortly, one of the single largest fighter plane contracts in the history of aviation, worth a massive US \$7 billion at least. Also in the race, is Sweden's Gripen and Russian advanced MiGs. The prospective deal has been the talk of military aviation circles for several months now.

Harriers, A-10s, F-16s, F/A-18 Hornets and United Kingdom Harrier GR.7s and Sea Harriers.

Northrop Grumman's airborne signals intelligence payload takes to air

Northrop Grumman Corporation's Airborne Signals Intelligence Payload (ASIP), a next generation signals intelligence sensor for the US Air Force, recently took to the air on its first flight

aboard the U-2 aircraft, launching the flight test phase of the programme. ASIP delivers enhanced signals intelligence capabilities to the warfighter. It detects, identifies and locates radar and other types of electronic and modern communication signals. A key attribute of the ASIP payload is an open, scaleable architecture that allows future system upgrades to be easily added and sensors readily reconfigured in support of evolving warfighter needs.

Air Marshal Fali Homi Major will be the new Chief of Air Staff



The Government has appointed Air Marshal Fali Homi Major presently Air Officer Commanding-in-Chief, Eastern Air Command, as the next Chief of the Air Staff with effect from the afternoon of March 31, 2007. The present Chief of the Air Staff, Air Chief Marshal S P Tyagi retires from service on March 31, 2007.

Air Marshal Major will become the first ever helicopter pilot to command the force. The force has strictly been the preserve of fighter pilot for the last 75 years.

Eurocopter signs with the French Gendarmerie for 37 EC135s

Eurocopter has signed a significant contract with the French Gendarmerie for the acquisition of 37 EC135 (12 firm orders and 25 options) valued at Euros 233 million. These EC135, which will be used for police missions, will replace the single-engine Ecureuil B, BA and B1 that the French Gendarmerie has been operating since 1980. The first helicopters will be delivered during the last quarter of 2008.



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