ISSN 2230-9225

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20 Years After Kargil

THE MAN WHO BOMBED TIGER HILL

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AIR MARSHAL R. NAMBIAR, AIR OFFICER COMMANDING-IN-CHIEF OF WESTERN AIR COMMAND, INDIAN AIR FORCE. THE COMMAND IS THE 7TH LARGEST AIR FORCE IN THE WORLD, THE WAY AIR MARSHAL PUTS IT.

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Subscription/Circulation
Annual Inland: ₹1,200 • Foreign: US$320

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COVER IMAGE

Reminiscing the Kargil Triumph: Air Officer Commanding-in-Chief Western Air Command, Air Marshal Raghunath Nambiar, standing in front of an IAF Mirage 2000 (Pic: IAF)

COVER DESIGN BY
SP's team

20 YEARS AFTER KARGIL WAR

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NEXT ISSUE: *50 Years of Apollo Mission*

While talking to *SP's Aviation*, Air Marshal Nambiar recounted how the providential availability of Litening targeting pods for 5 Mirage 2000 aircraft helped changed the course of the Kargil War. The IAF was lucky. Laser-guided bombs were meant to be inducted the following year. Twenty years later, India must ensure timely procurement of equipment for adequate readiness, so that the outcome of military challenges is not left to chance or good luck.

THIS YEAR, THE INDIAN FORCES CELEBRATED THE 20TH anniversary of the war with Pakistan in Kargil. This issue of *SP's Aviation* carries a very timely and an exhaustive interview with Air Marshal Raghunath Nambiar, presently Air Officer Commanding-in-Chief, Western Air Command, who incidentally is one of the three front runners to be the next Chief of the Air Staff of the Indian Air Force on retirement of the present incumbent on September 30, 2019. Posted at Indian Air Force Station, Gwalior as a Wing Commander during the Kargil War, he undertook a highly successful mission against the Pakistani forces on Tiger Hill. He was flying the Mirage 2000 that was equipped with the Laser guided bomb and the aircraft was equipped with the Litening targeting pod that enabled him strike the enemy target with devastating accuracy.

An area in which Indian scientists have done the nation proud is that of space exploration. Having registered a number successes in this domain, the Indian Space Research Organisation (ISRO) launched Chandrayaan-2, its second mission to the Moon. For the future, Indian scientists have a number of lofty plans which include a mission to the Sun, the first manned mission in space with three astronauts and the establishment of a space station by 2030. Reports on the launch of Chandrayaan-2 by Ayushee Chaudhary and the status of India in the domain of space by Air Marshal S.B.P. Sinha (Retd) figure in this issue of the magazine.

A major event on the global civil and military aviation scene in the recent past was the iconic Paris Air Show. The importance of this biennial event that was held from June 17 to 23 this year, can be judged from the fact that it was inaugurated by the President of France, Emmanuel Macron himself. With 'innovation' as the primary focus, the Air Show at Paris hosted a large number of exhibitors including start up companies from all across the world. A notable feature of the Paris Air Show was the thrust on efforts by the industry to address the challenge of degradation of the environment. The Air Show had on display aircraft with engines driven by electrical power in place of the conventional biofuels. A comprehensive report on the Paris Air Show by Ayushee Chaudhary of *SP's Aviation* has been included in this issue.

This issue carries a report on Israel's defence and aerospace manufacturing sector that is producing world class equipments. Israel, a very small country, has gradually and determinedly developed one of the largest aerospace and defence complex which has become the benchmark for self-reliance and aspiration for many countries to follow.

The Defence Research and Development Organisation has recorded a major achievement with the successful development of the Astra, its first all-weather Beyond Visual Range Air-to-Air Missile. This has propelled India into a group of just a few nations that have a weapon system of this capability and performance. A interesting column on Astra by Air Marshal S.B.P. Sinha (Retd) has been included in this issue.

All this and more in this issue of *SP's Aviation*. Welcome aboard and we wish you many happy landings!

Jai Hind!

JAYANT BARANWAL
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Owned, published and printed by Jayant Baranwal, printed at Kala Jyothi Process Pvt Ltd and published at A-133, Arjun Nagar (Opposite Defence Colony), New Delhi 110003, India.

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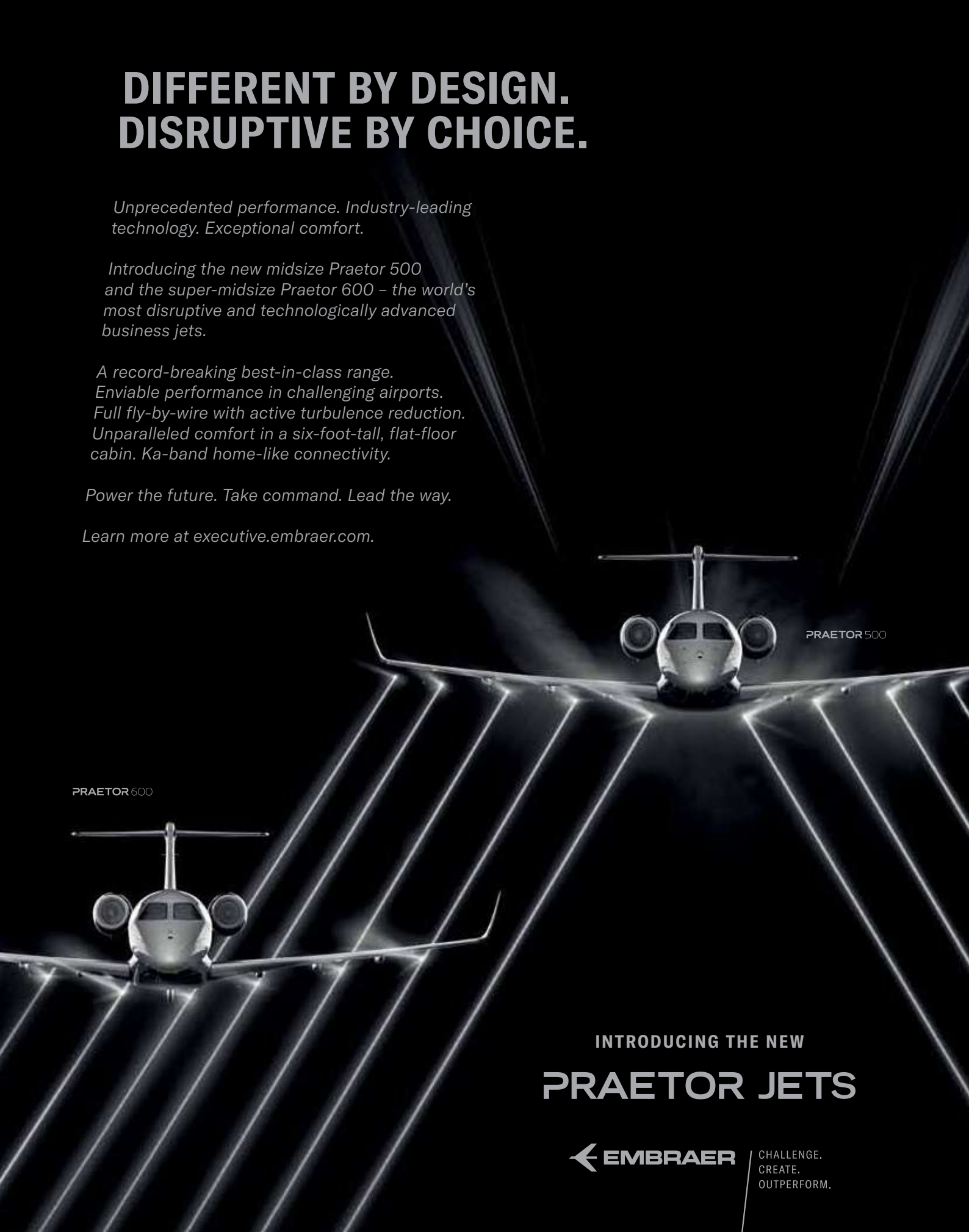

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THE MAN WHO BOMBED TIGER HILL TELLS US HOW THE WAR WAS WON FROM THE AIR

Inspired overnight integration of precision bombing kits on 5 Mirage 2000 jets changed the course of the war, Air Marshal **Raghunath Nambiar** reveals in an interview to **Vishal Thapar** of ***SP's Aviation***

THE GRAINY BLACK-AND-WHITE VIDEO OF IAF BOMBS HITTING TIGER HILL and Pakistani intruders scampering for life as bombs rained on their position, is one of the defining images of India's determined fight back, which set it on the course to victory in the Kargil War in 1999. This video was captured from the aircraft of Air Marshal Raghunath Nambiar, who flew intrepid, game changing sorties as a Wing Commander during the War.

NOW THE AIR OFFICER Commanding-in-Chief of the Western Air Command, he narrates the story of how the IAF used laser-guided bombs for the first time, without any prior training, to deliver a knock-out punch to Pakistani soldiers occupying the Kargil heights. It is a story of military enterprise and daring on the battlefield.

PHOTOGRAPH: SP GUIDE PUBNS

***SP's Aviation* (SP's): Air Marshal Nambiar, should we introduce you as the Man who Bombed Tiger Hill?**

Air Marshal Raghunath Nambiar (Nambiar): Yes, that's right. That was on the 24th of June. I was flying a Mirage 2000. My co-pilot in the rear seat was Squadron Leader Manish Yadav. We were tasked with dropping a laser-guided bomb on Tiger Hill. While there were just two of us in the aircraft, there were over a hundred of us on the ground. It was total teamwork. A lot of people strived long and hard, put in a lot of effort to make sure we were up in the air and dropping our bombs on this place.

SP's: Give us a sense of how you pulled it off. Precision bombing was very new for the IAF, that was in the process of integrating the Litening targeting pods.

Nambiar: There was a big element of luck in this. At that point in time, we had just procured the Litening pod. It had not been integrated on the Mirage 2000 and it was undergoing tests. We had five pods at this time. All five were developmental pods, with various versions of software with a lot of glitches and bugs. And, therefore, one of the biggest challenges for us was to make sure that they functioned in a proper manner. We had to first work on the pod, work on a new weapon which we had not dropped from the Mirage before and never been trained on. And most importantly, this was the first time the Indian Air Force (IAF) was employing a laser-guided bomb. The challenge was to make sure it went well. There was a huge amount of anxiety, big worry that probably things would not go right.

SP's: Did you have the time to simulate dropping of laser-guided bombs?

Nambiar: Oh, no, we had to take on this operation on our feet. The War had started. This was the 24th of June. Tiger Hill, which had a very important place in Kargil sector along that Valley which overlooked NH 1A – which is the National Highway. We had intruders sitting on top, very accurately reporting target information back the Artillery on the Pakistani side and this was causing havoc on our National Highway. It was very important for us to put a stop to that, which is why finally on the 24th of June, the IAF was tasked to get in and attack Tiger Hill.

SP's: What is your memory of flying those precision bombing sorties over Kargil, seeking tiny targets while flying supersonic at high altitude?

Nambiar: Tiger Hill had nine Arctic tents which were pitched on a small plateau at its very tip, just about 150 feet from the top. We were coming all the way from Adampur, that is just next to Jalandhar. The Mirages were based there and we had about 35 minutes of navigation to reach Tiger Hill. While Tiger Hill looks very spectacular from the ground, from the air, the big hills which stand out in the area are Nungkung and K2. These were clearly visible and Tiger Hill was a sort of puny feature in front of it. Finding Tiger Hill was not as simple as it looked because it was one peak among many in the neighbourhood. And I must tell you that being in a Mirage 2000 with a very accurate navigation system, made it relatively easy. Now laser-guided weapon delivery requires the aircraft to be accelerated to about 1,000 km per hour speed. And at those speeds, things happen very fast. We had lots of action to complete before the weapon was actually dropped and all this required a lot of team effort and team work. Squadron Leader Manish and I had known each other for some time. Manish was a very bright youngster, very capable and he was a big asset to have in the cockpit and the close coordination between the two of us is the reason why we hit the targets right.

> "We had just procured the Litening pod. It had not been integrated on the Mirage and it was in tests. We had 5 pods at this time. All 5 were developmental pods, with various versions of software with a lot of glitches and bugs.... We had to first work on the pod, work on a new weapon which we had not dropped from the Mirage before, never been trained on. And most importantly,... this was the first time the Indian Air Force was employing a laser-guided bomb"

SP's: There was the danger of the shoulder-fired Stingers (surface-to-air missiles), which had already brought down two Indian aircraft. How low were you while flying above the bombing targets? What were you doing to make sure that the fighters did not get hit?

Nambiar: Tiger Hill is at a height of about 16,800 feet. The number of Tiger Hill – like many other places have trigonometric height (for identification) was 5,062 metres. We were flying about 10,000 feet above that to keep ourselves safe from the Stingers. We were safe.

SP's: The IAF had a hesitant start. There were the initial losses. How did you get into gear? What convinced the leadership that these kind of precision strikes would work? After all, there was no precedent in the history of air warfare for anything like this.

Nambiar: I think the attack on Muntho Dhalo on the 16th of June had convinced the leadership that the Mirage was very potent and therefore, when the Litening and Paveway combination was available to us finally, and had proven itself capable of being delivered, it was but natural that they would task us for such an important target. And I think I must credit the leadership with taking the right decision, making the correct choices, and making sure that we were equipped with all this weaponry. You must remember that Litening pod was contracted for in 1997 and delivery had just started when the War broke out. So, there was a lot of forethought involved in our leadership who had decided four or five years earlier that we required a capability like the Litening pod. So, it is not something which happened because we wanted it so in 1999. There was a lot of thought and planning involved in getting us the weapon in 1999.

SP's: We'll go back to the spectacular video which was taken by the equipment on your aircraft. We saw the Pakistanis scampering, running for dear life when the precision bombs were raining on them. Could you see something like that from your eyes?

Nambiar: No, not at all. All we had was a four by four inch display which is just about the size of two cellphones – that was

the screen dimension – and that too with very poor resolution. I think today we are talking of 4K displays and retinal displays and things like that. That was a very poor display. The quality was not at all good. So what used to happen is after we used to carry out filming of these places, we used to take it back to our crew rooms and look at them very closely on large size television screen to make out exactly what we saw and confirming for ourselves whether what we saw was what we thought it was.

SP's: From an airpower perspective, how far have we come in these 20 years?

Nambiar: We've travelled a long way. We've made a huge amount of progress in every which way. Some of things which I'm very proud about is our communications. What we were in 1999 and what we are today is a world of difference. We have the AFNET deployed. We have the capability to now securely message each other with a huge modicum of safety and security and that is just one facet. Our weapon systems have improved tremendously. The LGBs (during the Kargil War) could go 7, 8, 10 km from the aircraft. Today, we have stand-off weapons like the Spice 2000 and the Crystal Maze which go across a much longer range. The BrahMos for example can go up to 450 km. I mean that is the IAF capability today. We've made a huge jump in capability terms.

SP's: So, is the air-launched BrahMos now an operational weapon?

Nambiar: It is undergoing a set of trials. But it is working and it has shown itself to be very spectacular, very accurate and we're in the process of operationalising it. It is just a matter of maybe weeks or months before we have the capability.

SP's: Tell us about what happened at Muntho Dhalo and Point 4388 which were the other big events in Operation Safed Sagar.

Nambiar: Let me tell you that the turning point was Muntho Dhalo. While Tiger Hill got all the attention because of a very spectacular video, the fact is that the Muntho Dhalo operation was the turning point. I don't think ever before in the history of our Air Force or in fact of the armed forces have we managed to achieve so much as we did in Muntho Dhalo. In one single attack with four Mirage 2000s dropping six 250 kg bombs each, we killed about 300 Pakistani soldiers. I think it was a spectacular and very successful attack and it was the turning point. Muntho Dhalo is located in the Eastern part of the Kargil sector. To my mind, after the 16th of June, when we hit Muntho Dhalo, from then onwards, the entire Pakistani infiltration attempts in the Eastern sector had come to a standstill. Tiger Hill still stood, but that was on the Western side. And the Valley leading into Tiger Hill which had a trigonometric height located on the Valley floor was 4388. So the logistic support for Tiger Hill used to flow through the Valley of 4388 from Gultari and come up the slope to Tiger Hill. That was also the way the battle was being progressed. So, 4388 was next in line after Tiger Hill. We had discovered 4388. There were lots of intrusions, there were lots of hangars which had been built into that valley and we went after them hammer and tong. We dropped something like 100 thousand-pound bombs in that Valley. Yes, hundred 500 kg bombs. There was a huge quantity of weapons thrown into that place.

"The turning point was Muntho Dhalo. While Tiger Hill got all the attention because of a very spectacular video, the fact is that the Muntho Dhalo operation was the turning point. I don't think ever before in the history of our Air Force or in fact of the armed forces have we managed to achieve so much as we did in Muntho Dhalo. In one single attack with four Mirage 2000s dropping six 250 kg bombs each, we killed about 300 Pakistani soldiers"

SP's: So, this was the kind of firepower which the Pakistanis were subjected to which perhaps broke their will. Sir, you were flying under tremendous constraints, not just on the edge of your operational envelope with precision equipment which you were flying for the first time, but there was also this big embargo not to cross the LoC. How big a challenge was it?

Nambiar: I must tell you something. The Mirage was not the first aircraft which I flew the Litening pod in. I had flown the Litening pod in, at that point in time, two other aircraft. I had flown the Litening on the F-16 and also on the Phantom 2000. Both of them in Israel while I was evaluating the Litening pod. That was in 1996-97. The pod was not yet fully ready and we were evaluating it on behalf of the Indian Air Force. So, when the Litening pod actually started inducting into the Indian Air Force, at that point, I was lucky enough to be at the right place at the right time. I was available for flying. I was at that time a Wing Commander posted in Gwalior and I was responsible for Flight Safety. And in a jiffy, when the war broke out, I was catapulted – without being asked when or where or how – into battle. Therefore, the first challenge was getting used to the fact that we were in hostile airspace, there were lives at risk and we were going the harm's way. But it was thrilling all the same. I can still feel the hair on the back of my hand stand. I can still recall that experience. It was like something really out of this world.

SP's: The Jaguars had the Litening targeting pods in greater numbers at that point in time. But could you explain why the Mirage 2000 was selected for these missions?

Nambiar: While we had bought 10 Litening pods for the Jaguar, they had not yet been integrated. The Mirages were ahead in the integration chain. And that is why the Mirages were used. And the Mirage moreover had great advantage when flying at those heights. The Jaguars had a problem of thrust. It was not possible for that aircraft to operate with the sort of relative freedom which the Mirage enjoyed at that altitude. Muntho Dhalo proved that the Mirage could target accurately even with dumb bombs. And having been equipped with the Litening pod, we were the only aircraft really capable of doing business in guided bombs at that high altitude. SP

The full text and the video of the interview has been uploaded on our websites: www.sps-aviation.com and www.spsmai.com

MOON-BOUND: CHANDRAYAAN-2 LAUNCH ON JULY 22, 2019, FROM SATISH DHAWAN SPACE CENTRE AT SRIHARIKOTA ON-BOARD GSLV MKIII

PHOTOGRAPH: ISRO

CHANDRAYAAN-2 INJECTED INTO EARTH ORBIT

India's first mission to land on the lunar surface will explore the South Pole and make India the fourth country globally to achieve soft-landing on Earth's only natural satellite

By AYUSHEE CHAUDHARY

PRIME MINISTER NARENDRA MODI WITNESSING THE LAUNCH OF GSLV MKIII ON JULY 22, 2019

PHOTOGRAPH: PIB

ON THE AFTERNOON OF JULY 22, 2019, A GEOSYNCHRONOUS Satellite Launch Vehicle Mark III (GSLV MkIII) rocket lifted off from the Satish Dhawan Space Centre (SDSC) in Sriharikota carrying India's ambitious mission to the Moon, Chandrayaan-2. This is India's second mission to the Moon and was previously scheduled to be launched on July 15. However, that time the launch vehicle suffered a technical snag about 56 minutes before lift-off and it was rescheduled for July 22. The 20-hour countdown began on the evening of July 21 at 18:43 hours IST for the launch which was planned on July 22 at 14:43 hours IST.

"On July 15, 2019, ISRO intelligently observed a technical snag. Team ISRO worked out and corrected the snag within 24 hours. For the next one and a half days, the required tests were conducted to ensure that corrections made were proper and in the right direction. Today ISRO bounced back with flying colours," said Dr K. Sivan, Chairman, ISRO, after GSLV MkIII-M1 successfully injected Chandrayaan-2 spacecraft into the Earth orbit, having completed all three stages of the launch vehicle.

The spacecraft is now revolving round the Earth with a perigee (nearest point to the Earth) of 169.7 km and an apogee (farthest point to the Earth) of 45,475 km. This launch marks the first operational flight of the GSLV MkIII.

"Today is a historical day for Space Science and Technology in India. I am extremely happy to announce that GSLV MkIII-M1 successfully injected Chandrayaan-2 into an orbit of 6,000 km more than the intended orbit and is better. It is the beginning of a historic journey of India to the Moon and to land at a site near its South Pole to carry out scientific experiments," Sivan added.

Embarked on a GSLV MkIII-M1, the ₹978-crore mission is aimed to land on the Moon on September 7, after several orbital phases. The three-stage GSLV MkIII, is India's most powerful launcher till date and is capable of launching four-tonne class of satellites into the Geosynchronous Transfer Orbit (GTO). For Chandrayaan-2, the GSLV MKIII-M1 will be carrying an Orbiter, a Lander (named Vikram) and a Rover (named Pragyaan) in a mission aiming to unveil information related to the lunar surface.

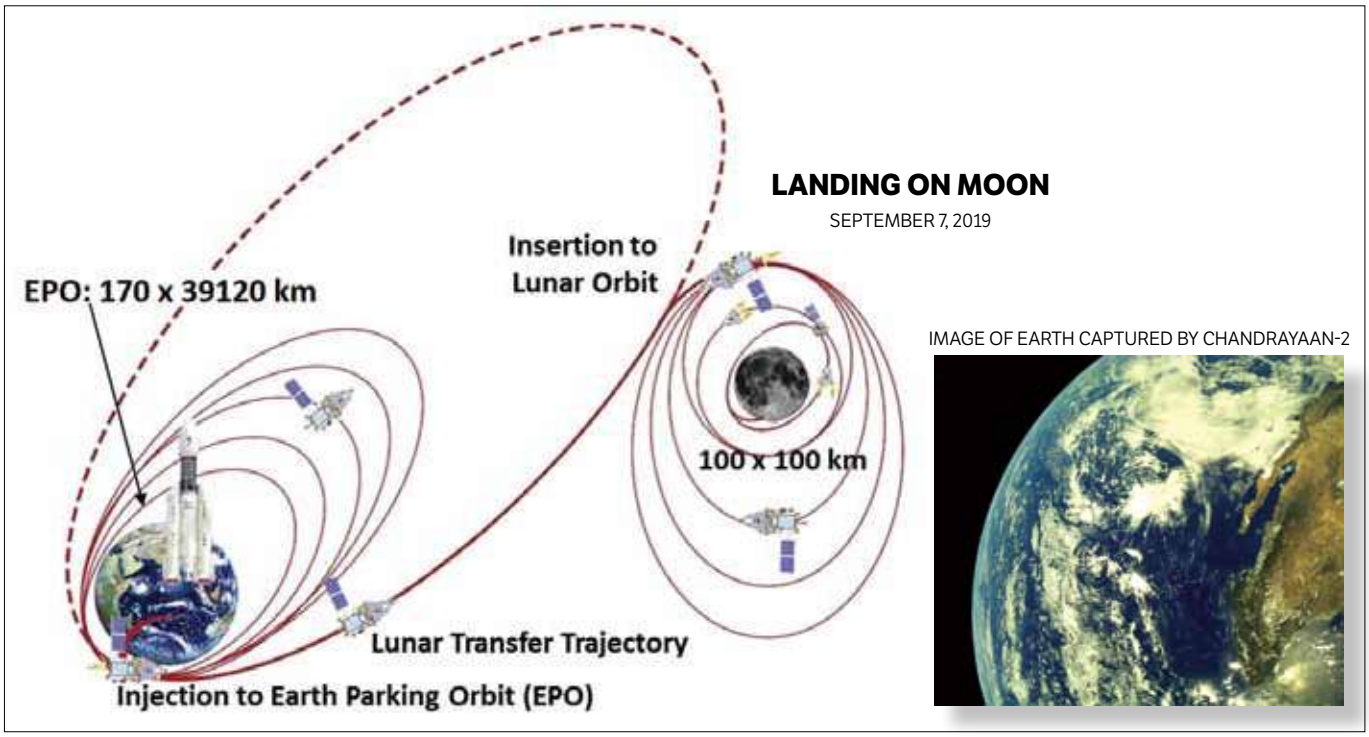
People from across the country registered to watch the launch from the SDSC spaceport in Sriharikota in Andhra Pradesh, where a special gallery was made specifically for the launch. Many people had also gathered outside the launch centre and thousands were glued to their screens for live streaming. ISRO also continued to update about each development on its twitter handle and shall continue to do so throughout the mission.

> The mission objective of Chandrayaan-2 is to develop and demonstrate the key technologies for end-to-end lunar mission capability, including soft-landing and roving on the lunar surface

WHAT HAPPENS NOW?

About 16 minutes 14 seconds after lift-off, the vehicle injected Chandrayaan-2 spacecraft into an elliptical Earth orbit. Immediately after separation of the Orbiter from the launch vehicle, the solar array of the spacecraft automatically got deployed and ISRO Telemetry, Tracking and Command Network (ISTRAC), Bengaluru, successfully took over control of the spacecraft.

Now the spacecraft would go around the Earth for about 23 days. After this, a series of manoeuvres would be carried



A GRAPHIC SHOWING THE PATH OF CHANDRAYAAN-2 FROM THE DAY IT WAS LAUNCHED TO THE DAY IT WILL LAND ON THE MOON

out to gradually raise the orbit and put Chandrayaan-2 on the lunar surface trajectory, which might take up to five days. Dr K. Sivan said that Chandrayaan-2 will perform 15 crucial manoeuvres in the days to come.

Once it has been injected into the lunar orbit, the Chandrayaan-2 would go around the Moon for a period of about 12 days. On the 48th day, i.e. on September 7, the landing on the surface of the Moon would be attempted. For this, the Lander would separate from the Orbiter and start what Dr Sivan said, will be 'the most terrifying 15 minutes of this mission'.

During these 15 minutes, Vikram would try to soft-land at an identified site on the lunar South Pole, which is a completely unexplored section of the Moon. This will indeed be the world's first space mission to conduct a soft landing on the Moon's South Polar Region, according to ISRO. The surface area in the South Polar Region of the Moon that remains in shadow, is much larger compared to that in the North Polar Region. This makes the Moon's South Pole an area of special interest, hinting at the possibility of the presence of water in permanently shadowed areas around it. ISRO also informs that in addition, the South Pole region has craters that are cold traps and contain a fossil record of the early Solar System. Moon's South Polar Region is also where India's first Moon mission, Chandrayaan-1 had detected traces of water.

Prime Minister Narendra Modi congratulated the ISRO team and also tweeted about this unexplored expedition.

Post the landing of the lander Vikram, the Rover Pragyaan will roll out and conduct experiments on the lunar surface for one lunar day which is equivalent to 14 Earth days while the orbiter will continue its mission for one year. The instruments on the Rover will analyse the surface and send back data. The orbiter will move around the Moon for remote sensing, while the various science payloads will gather information on lunar topography, mineralogy, elemental abundance, lunar exosphere and signatures of hydroxyl and water-ice. The landing is crucial also because it marks the beginning of the 14-daylight period on the Moon, which is critical for conducting experiments by the solar-powered Lander and Rover.

The mission objective of Chandrayaan-2 is to develop and demonstrate the key technologies for end-to-end lunar mission capability, including soft-landing and roving on the lunar surface. On the science front, this mission aims to further expand our knowledge about the Moon through a detailed study of its topography, mineralogy, surface chemical composition, thermophysical characteristics and atmosphere leading to a better understanding of the origin and evolution of the Moon.

The orbiter had a lift-off weight of about 2,369 kg, while the lander and rover weighed 1,477 kg and 26 kg respectively. The rover can travel up to 500 metres and relies on electric power generated by its solar panel for functioning.

Chandrayaan-2 has several scientific payloads with the Orbiter carrying eight payloads, the lander carrying three and the rover two. Besides, a passive experiment is included on the lander. The Orbiter pwayloads will conduct remote-sensing observations from a 100 km orbit while the Lander and Rover payloads will perform in-situ measurements near the landing site.

The ground facilities constitute the third vital element of Chandrayaan-2 mission. They are performing the important task of receiving the health information as well as the scientific data from the spacecraft. They are also transmitting radio commands to the spacecraft. The Ground Segment of Chandrayaan-2 consists of Indian Deep Space Network, Spacecraft Control Centre and Indian Space Science Data Centre.

This is India's maiden attempt to land on the lunar soil. As of now, only Russia, USA, and China have been successful in achieving soft-landing on the Moon. If successful, India would be the fourth country to achieve this feat! SP

PHOTOGRAPH: ISRO, ISRO TWITTER

INDIA: A SPACE SUPER POWER

India's successful space programmes have encouraged it to launch ambitious future projects that include another mission to the Moon, mission to the Sun, manned space mission and establishing a Space Station

INDIA BEGAN ITS SPACE RESEARCH PROGRAMME IN 1962 LED by the Indian Space Research Organisation (ISRO). From the very beginning, the programme was focused on developing capabilities in three distinct fields related to 'Satellites for Communication and Remote Sensing', 'Space Transportation System' and 'Application Programmes'. India's first satellite 'Aryabhata' was launched in April 1975 using a Soviet launch vehicle.

During the 1980s, ISRO designed and developed capabilities for in-orbit management of space systems together with the associated ground systems and also the development of Augmented Satellite Launch Vehicle (ASLV). During the 1990s, ISRO developed satellites for the multi-purpose Indian National Satellite (INSAT) and Indian Remote Sensing (IRS) programmes along with operationalisation of Polar Satellite Launch Vehicle (PSLV) and the development of Geo-synchronous Satellite Launch Vehicle (GSLV). The 21st century witnessed a giant leap in the Indian space programme.

ISRO launched its first lunar mission on spacecraft named 'Chandrayaan-1 in October 2008 with indigenously researched and developed technology. Chandrayaan-1 successfully entered the lunar orbit in November 2008 and the 'Moon Impact Probe' separated and hard-landed at the planned spot on the Moon. Chandrayaan-1 discovered water over the lunar surface and mapped the mineral and 3D topography of the Moon. India is the fourth country to reach the Moon after USA, Russia and China.

In November 2013, ISRO launched its first inter-planetary mission to Mars on spacecraft named 'Mangalyaan', which successfully entered the Martian orbit in September 2014. India is the fourth country to reach the Mars after USA, Russia and the EU and first to reach in the first attempt. At a cost of ₹450 crore, Mangalyaan is the cheapest Mars mission till date.

MAJOR ACHIEVEMENTS IN RECENT TIMES

India is running a vibrant space programme for its security, economic development and technological progress. So far, ISRO has launched 115 satellites; three in 1970s, 11 in 1980s, 16 in 1990s, 24 in first decade of 21st century and 61 till date in the current decade. India holds the world record for the highest number of satellites in a single mission by launching 104 satellites mounted on a single launch vehicle. ISRO has launched the 'Indian Regional Navigation Satellite System' (IRNSS) to provide accurate position information service in India and the region extending up to 1,500 km beyond its boundary with a position accuracy better than 20 metre. IRNSS has eight satellites, of which three are in geostationary orbit and four in geosynchronous orbits. In May 2017, as a diplomatic initiative, India launched 'South Asia Satellite' to provide communications, remote sensing, resource mapping and disaster management applications to its South Asian neighbours.

On July 22, 2019, at 1443 IST, ISRO successfully launched the Chandrayaan-2, a mission to the Moon consisting of the Orbiter, 'Vikram' Lander and 'Pragyan' Rover modules. The Orbiter has successfully established its orbit around the Moon and the Lander is planned to soft land on the lunar South Pole on September 7, 2019 after which the Rover will emerge from the Lander and move on its wheels on the lunar surface for scientific experiments.

Further, India has planned the 'Aditya-L1', India's mission to the Sun in 2020. Launch of 'Gaganyaan', the first Indian manned space mission is planned in 2022 or earlier. Gaganyaan will carry three Indians (Gagannauts??) into low earth orbit of 300 to 400 km for seven days. With the launch of Gaganyaan, India will join Russia, US and China in sending humans into space. Further, ISRO has planned its own 20-tonne Space Station by 2030 to conduct microgravity experiments.

The importance of space and satellites is growing at a rapid pace and India has become a major player in the global space race with significant number of space assets. Defending and securing valuable Indian space assets is also very important. India successfully demonstrated its capability to hit a target in space with Anti-Satellite (ASAT) weapon in March 2019. India is the fourth country to do so after USA, Russia and China.

PLANS FOR THE FUTURE

To further streamline exploitation of space, the Indian government has decided to create Defence Space Agency (DSA), a joint organisation headed by an Air Vice Marshal and manned by personnel drawn from the Indian Army, the Indian Navy and the Indian Air Force. The DSA will coordinate and oversee all military activities in space. Further, the Indian government has decided to create 'Defence Space Research Agency' (DSRA) headed by a scientist of the rank of Joint Secretary and manned by scientists. The task of DSRA will be to develop space warfare weapons and technologies. DSA, DSRA, ISRO and Defence Research and Development Organisation (DRDO) will interact closely with each other towards research and development activities related to refining of the already demonstrated kinetic ASAT capability and further develop non-kinetic ASAT capabilities.

Having ticked all boxes towards achieving its aim of securing its assets in outer space, India will shortly conduct a table-top war game called 'IndSpaceEx' involving all stakeholders to validate strengths, weaknesses and vulnerabilities of its space policy and systems to draw lessons for their further improvement.

India's successful space programmes have encouraged it to launch very ambitious future projects that include another mission to the Moon, a mission to the Sun, manned space mission and establishing a Space Station. SP

—By Air Marshal S.B.P. Sinha (Retd)
Former Deputy Chief of the Air Staff and Air Officer Commanding-in-Chief of Central Air Command, IAF

DASSAULT UNVEILED ITS NEW-GENERATION FIGHTER AT THE PARIS AIR SHOW 2019. SEEN HERE IS ERIC TRAPPIER, CEO OF DASSAULT AVIATION WITH THE MOCK UP.

PHOTOGRAPH: PARISAIRSHOW.TV

FOCUSED ON INNOVATION, THE OLDEST AIR SHOW REPAINTS AERIAL COMMUTE

From captivating displays staged on the ground as well as in the sky to transporting futuristic experiences, 53rd edition of the Paris Air Show wraps up with strong imprints

By **AYUSHEE CHAUDHARY**

AFTER MUCH ANTICIPATION AND BUZZ, THE LONGEST-RUNNING air show successfully completed its 53rd edition leaving much to reminisce. Started in 1909, the Paris Air Show has continued to be the largest trade show through decades and hence the most anticipated. The biennial air show was held this year from June 17 to June 23 at Le Bourget Parc des Expositions that has been its venue since 1953. Despite being the oldest, the Paris Air Show carries novelty at its heart so much so that this recently wrapped edition was outlined with 'innovation' as the main theme.

Paris Air Show has grown to be a hub for major developments in the global aerospace market. Having the first four days reserved for trade visitors and the rest three open to the general public with the fifth one dedicated to students, the air show attracts traders as well as general public alike. Inaugurated by the French President, Emmanuel Macron on June 17, this year, the air show hosted 2,453 exhibitors from 49 countries, 150 start-ups from 21 countries and 1,76,630 general public visitors.

From important discussions over cyber security to making way for the next generation of professionals through the careers plane (a space dedicated to employment and training); from showcasing the established aerospace players to the future of air mobility, from captivating static display to thrilling flying displays, the Paris Air Show had it all.

Accompanying young and old, was the show's mascot, Aleo who welcomed everyone ensuring they discover the history of aeronautics and space with all fun and simplicity.

A VISUAL RETREAT

Several interesting displays, both static and aerial as under and demonstrations on the military side as well as commercial aircraft, adorned the 53rd edition of the Paris Air Show.

- The precision aerobatic demonstration unit of the French Air Force, the Patrouille Acrobatique de France, has continued to be a highlight and the main attraction of the Paris Air Show as they go around painting the sky blue, white and red through their multiple aerial stunts and formations.
- Performance by a Dassault Rafale fighter jet during the aerobatic display, was another favourite with many other commercial and military aircraft of the likes of Airbus A350 garnishing the sky at Le Bourget.
- The first public appearance was made by Elbit Systems' Hermes 45 Small Tactical Unmanned Aircraft System (STUAS) at the company's static display area.
- Some of the other attractive aircraft displayed were Mitsubishi SpaceJet which was unveiled after being rebranded from the MRJ.
- Indian Airline SpiceJet also displayed one of its new generation versions of the Bombardier Q400.
- Bombardier's Global 7500 jet was also among the business jets on display at the air show.
- The e-commerce giant, Amazon also displayed its cargo aircraft stating 'Prime Air'. Amazon has five Boeing 737-800BCF on lease.
- AirAsia debuted at the air show with its first Airbus A330-900neo.

TRANSPORTING INTO A WORLD OF VIRTUAL REALITY

Placed in the Concorde Hall of the Air and Space Museum at Le Bourget, the future-focused exhibition under the name of 'Paris Air Lab', returned to the Paris Air Show after its successful debut in 2017. Committed to innovations, this Air Lab ensured to be a gateway into the future, taking the visitors on an extraordinary journey to discover tomorrow's challenges namely climate change, artificial intelligence and future of mobility. Through several spaces dedicated to innovation, this exhibition space offered visitors some interesting and innovative first-hand, near-life experiences. Through animations and Virtual Reality (VR), Paris Air Lab allowed the visitors to live some of the major futuristic aerospace adventures. Visitors had the opportunity to capture themselves in zero gravity at the CNES exhibition stand, take a walk in space (virtually), experience some 'space cooking' and even be a part of the space-themed 'escape game' and accomplish the mission making way through the clues.

Paris Air Show also organised a 'rocketry challenge' for the young aviation enthusiasts in the age group of 12 to 18 years. The challenge that took place in the centre of the show involved sending up of three raw eggs in a rocket that must remain unbroken on landing. The final round of the international competition this year was seen between four teams each from France, the United Kingdom, the United States and Japan. The British team came out as winners.

PAS also organised a 'rocketry challenge' for the young aviation enthusiasts in the age group of 12-18 years. The challenge that took place in the center of the show involved sending up of three raw eggs in a rocket that must remain unbroken on landing.

Among other highlights on supersonic developments, electrifying flying, sustainable and innovation-driven industry, major attention fell on the arrival of the US Air Force's new military derivative aircraft, the Boeing KC-46 Pegasus aerial tanker based on the popular Boeing 767 passenger aircraft that made its debut at the 2019 Paris Air Show.

The 53rd edition also celebrated music on the show for the first time. On the occasion of the celebration of music in France, on June 21, as many as eight groups punctuated the visitors' arrival with classical music, jazz, rock and Brazilian music creating a real moment of relaxation and conviviality leaving everyone under a tranced ambiance. SP

PHOTOGRAPH: DASSAULT AVIATION

ELECTRIFYING FLYING FOR REDUCED EMISSIONS

A significant number of hybrid and electric aircraft made way to the longest-running air show, marking a new era of aviation to be followed

ISRAELI STARTUP EVIATION AIRCRAFT'S ALL-ELECTRIC AIRPLANE CHRISTENED AS ALICE ▶

□ **AYUSHEE CHAUDHARY**

There is increasing focus on the alarming environmental hazards resulting from various industrial activities. The good news however, is that almost every industry is understanding their responsibility and are trying to take the necessary initiatives. The aviation industry globally is itself known to produce around three per cent of carbon dioxide emissions and the rapid expansion of this sector expected in the future only predicts further increase in the levels of emissions. Acknowledging this concern, the aviation industry is taking significant steps such as the eventual shift towards sustainable alternative fuels and coming up with electrical alternatives for flying.

Tapping into further innovation and efficiency, both aerospace and defence suppliers as well as Original Equipment Manufacturers (OEM) are transforming the way they function with innovative designing and advanced technologies in the form of air taxis and electrically-propelled aircraft.

The Paris Air Show which was all about innovation and future, witnessed a considerable amount of stress on hybrid and electric aircraft many of which were on display. From the industry titans to the start-ups, all came forth with progressive technologies that present a more environmentally efficient future. A new era of aviation was hence on display at Le Bourget during the 53rd edition of the Paris Air Show with "flying taxis" as well as commercial engines that employ electric motors from manufacturers such as General Electric. Some of such vehicles on display at the air show were:

- **Eviation's Alice.** Gathering the maximum attention among the electric aircraft was the prototype of Israeli startup Eviation Aircraft's all-electric airplane christened as Alice. The debuting vehicle that can fly nine passengers up to 650 miles on a single charge, announced a deal at the air show with US regional airline Cape Air to launch commercial flights. "This aircraft is not some future maybe. It is there, ready and waiting," said Omer Bar-Yohay, CEO of Eviation which claims the aircraft can cut airline operating costs by 70 per cent. With testing and certification already underway, the plane that cruises at 10,000 feet should be ready by 2021. The plane uses one main "pusher" propeller at the tail, and two more on the wingtips which are powered by batteries.
- **Airbus' Vahana.** An all-electric vehicle demonstrator from A3 (Airbus' Silicon Valley innovation centre) is Airbus' innovative project, Vahana, the prototype of which was on display at the Paris Air Show clearly aatracting attention. A single-seat, tilt-wing vehicle demonstrator that focuses on advancing self-piloted, electric vertical take-off and landing (eVTOL) flight, Vahana has flown over 80 full-scale test flights.
- **EcoPulse.** A hybrid aircraft to be tested by 2022 was also announced by Airbus in collaboration with aviation industry conglomerate Daher which will look after components and systems installation and rocket engine maker Safran that will provide a propulsion system for the aircraft called EcoPulse. Airbus will be responsible for batteries and aerodynamic design. A distributed hybrid propulsion system including turbo-generator powering electric motors and propellers, will run the plane. Hybrid propulsion system ensures reduced emissions as well as less aircraft noise pollution. A small model of the distributed hybrid propulsion system was also on display.
- **Boeing's Flying Taxi.** Another futuristic aircraft prototype on display was Boeing's Passenger Air Vehicle (PAV), an eVTOL air taxi that claims to represent the next generation of autonomous electric aircraft that are safer, quieter, and cleaner. PAV is asserted to be able to autonomously transport passengers, plan routes, respond to contingencies and detect and avoid unexpected obstacles. Aurora Flight Sciences is developing both two and four-passenger variants with cargo options, ensuring PAV's potential to change how people, goods, and ideas move throughout the world. Additionally, Boeing announced its investment in Brazil's effort to set up a sustainable aviation fuel industry, focusing on steps that enhance social,

Additionally, Boeing announced its investment in Brazil's effort to set up a sustainable aviation fuel industry, focusing on steps that enhance social, economic and environmental benefits to local communities involved in the feedstock development used to produce sustainable aviation fuel (SAF).

PHOTOGRAPH: ASDS MEDIA

economic and environmental benefits to local communities involved in the feedstock development used to produce sustainable aviation fuel (SAF).

- **Project 804.** A hybrid-electric project dubbed as Project 804 was also unveiled by United Technologies (UTX) as it announced plans to merge with defence contractor Raytheon. Built on a mid-sized regional turboprop, the plane uses existing airframe, systems and propellers; but innovates with batteries and a two-megawatt hybrid-electric propulsion system. The planes are aimed for a 2022 launch and to be ideal for shorter haul flights between regional airports.
- **Cessna 337.** Aviation start-up Ampaire announced a major deal with Personal Airline Exchange for the order of converting 50 electric planes. Ampaire has been working on the conversion of existing aircraft such as the Cessna 337.
- **E-Fan X.** Another major deal was cracked with the UK engineering company Rolls-Royce acquiring the electric flight division of Germany's Siemens eAircraft. The purchase of the electric and hybrid-electric aerospace propulsion business was announced by Rolls-Royce at the air show. Further, in a collaboration with French Airbus, the two companies will develop another hybrid-electric propulsion system entitled E-Fan X that will apparently be big enough to power a large jet plane.

THE SONIC SENSATION

With the constant and rapid advancement in aviation, the supersonic regime is among the most awaited. The 53rd edition of the Paris Air Show was clearly a demonstration of what the flying would look like in the future.

- Even though it is still in the conceptual stage, Lockheed Martin Aeronautics' unveiling the design of a new supersonic airplane during the air show was a perfect knock at the door that opens into this era of supersonic air commute. A sleek twin-engine jet plane that will fly at Mach 1.8, carrying 40 passengers, the Lockheed Martin's supersonic aircraft is capable of trans-Pacific routes. The highlight of the airliner is how it manages to do away with the issues of sonic boom and airport noise. The design ropes in on the company's work with NASA in creating the X-59 Quiet Supersonic Technology X-plane that will not produce the sonic boom which is specifically linked with such aircraft breaching the sound barrier. The sound created will apparently be as loud as a car door closing. The X-59 is expected to undertake its first flight in 2021.
- Supersonic transport start-up Boom Supersonic made the announcement of partnering with aviation design specialists JPA Design for the cabin interiors for its Overture Mach 2.2 airliner which presently is under development. In a press conference during the air show, Boom founder and CEO Blake Scholl informed that Boom is nearing completion of the composites-intensive XB-1, a subscale prototype of the Overture that is expected to be rolled out by the end of 2019 and test flew sometime in 2020.
- Industry behemoths Northrop Grumman and Raytheon announced their partnership at the Paris Air Show for the creation of a new hypersonic weapon. The unnamed weapon is expected to travel at speeds higher than Mach 5. While Raytheon will build the missile, Northrop Grumman will make a scramjet engine to power the missile. SP

AEROSPACE MAGNETS GET DOWN TO BUSINESS

Exclusive launches, bulk buying and certification nudge celebrations for manufacturers at the Paris Air Show 2019

AIRBUS' MUCH ANTICIPATED LONG-RANGE A321XLR ▶

PHOTOGRAPH: AIRBUS

□ **AYUSHEE CHAUDHARY**

Rightly keeping up to its tagline, 'where the aerospace leaders get down to business', the Paris Air Show witnessed a plethora of airplanes bought, sold and many deals concluded. This edition in particular of the air show, however, came across as more about strategy than just buying. Some of the major names that had significant developments and announcements are as under.

AIRBUS

From commercial to military to electric aircraft, Airbus has had quite a prominent presence as under at the Paris Air Show 2019.

- **A321XLR.** A major highlight remained the launch of Airbus' much anticipated long-range A321XLR. The single-aisle plane that can undertake up a ten-hour flight, is being looked at as an economical solution for airlines wanting to serve long distance routes between smaller cities. The launch came with the announcement of 27 initial orders for the plane from Air Lease Corporation. The company was to order as many as 100 aircraft from Airbus that included 50 A220-300s and 23 A321neos apart from the A321XLR. As the show advanced, orders were pouring in for Airbus A321XLR by day three. Qantas Group ordered 10 of these aircraft and converted orders for 26 existing A321neos to orders for A321XLR. American Airlines also ordered around 20 and converted about 30 A321neo orders to XLR. IndiGo Partners also tentatively ordered 32 XLR aircraft and converted 18

existing A320neo family orders. Airbus claimed that XLR now boasted of the longest range single-aisle plane in the world at 4,700 nautical miles. The plane can take 244 passengers, but on a long-range trip, the number of seats would reduce to about 200. Airbus also added that the routes would now open up to operators who had an interest in flying routes such as India to Europe or China to Australia.

- **Airbus A320neo.** Tentative order for 11 of this jet was received from China Airlines and that of around 20 from Lessor Accipiter Holdings. Even Saudi Arabian Airlines is expected to boost A320neos family fleet up to 100.
- **A330 MRTT.** During the Paris Air Show, senior executives of Airbus and Lockheed Martin also met for some "tanker talk" in the backdrop of the Airbus A330 Multi Role Tanker Transport (A330 MRTT) with an agreement in place to explore opportunities for slae of this platform in the US military.
- **SmartForce.** Seven new products for its military customers under its digital support services offering SmartForce, were also launched by Airbus at the air show. The seven services consist of three dedicated services for military aircraft, two for military helicopters and two additional ones shared by military aircraft as well as helicopters.
- **Next Generation Fighter.** A real-life size model of the Next Generation Fighter was also revealed at the air show by Airbus and Dassault Aviation.

BOEING

Contrary to anticipation, Boeing refrained from the announcement of any new plane. With the latest version of Airbus' XLR being launched, the industry was hoping Boeing also to announce its New Midsize Aircraft (NMA), alternatively known as the 797. Boeing's stance stood on a shaky pedestal as the two 737MAX crashes that grounded the fleet, still seem to be alive enough with no-entry date in sight and the trust of people thoroughly shaken.

- Airlines too have not been placing many orders and Boeing looked dependent on freighter orders to occupy the Boeing 777 slots. While Qantas Airways committed to buying five Boeing 777Fs, China Airlines ordered about six and ASL Aviation Holdings also tentatively agreed for around 10 of the 737-800BCFs. Additionally, there were also reports of a deal with GECAS for around ten 737-800 converted freighters.
- Among the passenger aircraft, Turkmenistan Airlines ordered a Boeing 777-200LR and Air Lease Corporation committed to buy five wide-body 787 Dreamliners while Korean Air announced its intent to acquire thirty 787 Dreamliners, ten 787-10s and 787-9 for a deal worth $6.3 billion.
- The high-point for Boeing, however, was the announcement of a letter of intent from International Airlines Group (IAG), the parent company of British Airways, Iberia, Vueling, Aer Lingus and Level for around 200 of the 737MAX for $24 billion.

EMBRAER

While Airbus and Boeing were the major players, even smaller manufacturers were not very far from action.

- A significant feature of the air show was seen with the KLM Royal Dutch Airlines committing to Brazilian manufacturer Embraer for a tentative order of 15 Embraer E195-E2 aircraft. In addition to this, 20 purchase rights valued $2.5 billion at market prices when fully congealed. Hence, in all Embraer announced KLM's intention to buy up to 35 E195-E2 Jets.
- Embraer also struck a deal with United Airlines for the purchase of up to 39 E175s for about $1.9 billion. With deliveries expected in the second quarter of 2020, the order includes 10 firm and 19 options in a 70-seat configuration. These aircraft are expected to replace the older 70-seat aircraft presently in operation by United's regional partners.

(TOP) BOEING 787-9 AIR TAHITI NUI LANDING DURING PAS 2019;
(ABOVE) EMBRAER E195-E2 PROFIT HUNTER IN YET ANOTHER INTERESTING LIVERY.

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SAFRAN

Safran Helicopter Engines had a piece of good news in the form of the European Aviation Safety Agency (EASA) Type Certification that it received for its Arrano 1A engine. The new generation engine in the 1,100 to 1,300 shp power range, aptly suitable for new four-to-six tonne helicopters, is installed in the Airbus Helicopters H160. Arrano Programme Director Cyrille Ressejac-Duparc said, "This engine features low operational and supports costs, easy maintenance and a lower environmen-

PHOTOGRAPHS: ASDS MEDIA, SAFRAN GROUP

(LEFT) EASA CERTIFIES SAFRAN ARRANO 1A ENGINE POWERING H160 HELICOPTER; (RIGHT) INDIGO PLACES $20 BILLION LEAP-1A ENGINE ORDER WITH CFM.

tal footprint. After a test campaign of 10,000 hours, including 2,000 in flight, we are now ready to support H160 entry-into-service. Safran Helicopter Engines is also strongly committed to developing the HIL, the military variant of the H160".

CFM INTERNATIONAL

CFM international, a joint venture between GE Aviation and Safran Aircraft Engines, registered orders for $50.2 billion, setting new records in terms of total engines as well as total value of sale during the 2019 Paris Air Show.

- Orders and commitments for over 1,150 LEAP engines were announced by the company, along with long-term service agreements for a total value of approximately $50.2 billion at list price. The LEAP engine is characteristic of 3D-printed fuel-nozzle tips and parts from space-age materials called ceramic matrix composites (CMCs), which help it save fuel, lower emissions and achieve other performance benefits. These engines are designed for next-generation passenger jets developed by Airbus, Boeing, and COMAC. Orders and commitments for LEAP engines recorded on the eve of the Paris Air Show were valued at more than $255 billion.
- On the first day of the air show, CFM announced signing the largest single jet engine order in history with the low-cost Indian airline, IndiGo. CFM will supply IndiGo with its LEAP-1A engines to power 280 Airbus A320neo and A321neo aircraft. The contract is valued at over $20 billion at list price. A long-term service agreement was also signed.
- Malaysian low-cost airline, AirAsia also finalised an agreement with CFM for the purchase of 200 LEAP-1A engines to power the airline's 100 Airbus A321neo. The airline also extended its 20-year Rate-Per-Flight-Hour (RPFH) agreement to i8nclude its entire fleet of 808 LEAP-1A engines for a combined total value of $23.1 billion at list price.
- Dublin-based international aircraft leasing company, AvolonHoldings Limited too announced an order for 140 LEAP-1A engines from CFM. The order valued at $2 billion is for powering 70 Airbus A320neo family aircraft. Avolon has been CFM's customer since its launch and with this latest announcement, CFM LEAP-1A engines will be powering 105 of these aircraft. This is Avolon's largest ever engine order and one of the biggest ever engine transaction with a lessor for the LEAP engine.
- The global, full-service aircraft lessor, CDB Aviation, also announced an order for CFM's LEAP-1A engines to power 45 Airbus A320neo aircraft, valued at more than $1.3 billion dollars at list price.

ATR

Franco-Italian aircraft manufacturer ATR signed a letter of intent with regional aircraft leasing specialist Nordic Aviation Capital (NAC) for 35 firm ATR-600s. The letter includes the options for a further 35 and purchase rights for another 35. The deliveries of the initial 35 aircraft will start in 2020 and will be completed in 2025, ensuring that market demand is satisfied over the five-year period. More than 100 speculative ATR aircraft orders have been turned into deliveries to NAC, since 2010.

MITSUBISHI

The Japanese planemaker Mitsubishi Aircraft Corporation signed its first Memorandum of Understanding after the changed design and the rebranding of Mitsubishi Regional Jet to SpaceJet. The narrow-body regional plane should be ready for the market in 2023, the aviation firm stated during the air show.

> Yet another significant feature of the show was seen with the KLM Royal Dutch Airlines committing to Brazilian manufacturer Embraer for a tentative order of 15 Embraer E195-E2s. In addition to this, 20 purchase rights valued $2.5B at market prices when fully congealed.

COLLINS AEROSPACE

Aerospace Company, Rockwell Collins, secured maintenance agreements for more than $1.5 billion from global customers. Including contract wins for its Aerostructures and Power and Controls businesses, the company broadened its aftermarket services reach and boosted its backlog with these multi-year deals. Collins Aerospace also won contracts with several unannounced customers to support Airbus A320 and Boeing 787 nacelles under its FlightSense programme. This programme is a subsystem and health management service offering that gives operators different levels of coverage to match their needs. SP

PHOTOGRAPHS: SAFRAN GROUP, CFM

STATE-OF-THE-ART COCKPIT OF PRATEOR 600

EMBRAER'S UX DESIGN PHILOSOPHY

Jay Beever, Vice President, Interior Design, Embraer Executive Jets, believes that true innovation must be the design driver that elevates the full spectrum of the customer experience, from user experience to operational efficiency to ownership excellence

By JAY BEEVER

PHOTOGRAPHS: EMBRAER

SUPER STYLISH AND SPACIOUS CABIN OF PRAETOR 600

How Does Innovation Elevate the User Experience?

The proliferation of Access Economy business models raises a fundamental question about customer experience. Who is the customer? While user experience—or UX—is prominently highlighted as the differentiating factor, sustainability of this new ecosystem demands that the stakeholders who make it available also enjoy the ultimate customer experience, as a profitable operator or as an aircraft owner—or both.

THE UX DESIGN PHILOSOPHY

User experience design must prioritize the same freedom of movement brought by business aviation travel inside the aircraft. The experience of space must be translated into individual comfort. When space becomes personal, the ability to personalize one's environment enhances their sense of freedom.

Comfort is human, and so are the factors that dictate the design of personal space and comfort. The world's finest products are typically appreciated for their exquisite craftsmanship. To achieve this goal, planning and deep study into the final execution are required before the work of assembly even begins. The final aesthetic should be beautiful and robust, pleasing the passengers with each feature and movement, and delighting the senses with multiple layers of detail that keep them wondering how it was done.

THE UX INNOVATION QUEST

While ergonomics are the foundation of comfort and craftsmanship defines elegance, innovation must drive our quest to deliver the ultimate customer experience, for the users, the owners, and for the operators who make it all happen, every day. This quest must be perpetual.

Every now and then someone comes along and takes a closer look at a product we already believe to be a modern marvel of science and technology, and of course, human ingenuity. Bicycles, vehicles, boats, and aircraft, have each become objects of innovation, immediately upon invention.

THE UX ROLE OF TECHNOLOGY

Technology should be invisible but the benefits must serve the customer, just as fly-by-wire transparently makes flights the smoothest possible. Introducing a new technology as a new interior design style will only create the necessity for a new style in the future, for the same reason: more new technology. For technology to serve its purpose in the interior design of an aircraft, it must be transparent. As it disappears aesthetically and only appears functionally, on demand, it becomes timeless. Only then will it fulfill its role, which is to serve the customer, not vice-versa.

Also transparent is the fundamental aspect of interior design; architecture. Traditionally, changes in aircraft interiors have required complete replacement of affected elements. Innovation in aircraft interior architecture has allowed for the creation of zones of personalization as well as maintenance accessibility for rapid replacement operations between flights.

As the popularity of the Access Economy increases, aircraft and their interiors will have to stand the test of time as they serve their users in a high utilization environment and deliver profitable results to their owners, while offering efficiencies that drive sustainable operations. True innovation must be the design driver that elevates the full spectrum of the customer experience, from user experience to operational efficiency to ownership excellence. SP

FOR MULTIMISSION: HERON TP MALE UAV

ISRAELI MUSCLE

Israel's defence and aerospace manufacturing sector that are doing a stellar job, working on leading technologies and developing world class products

By VISHAL THAPAR

ISRAEL HAS PROVED TO BE ONE OF INDIA'S MOST RELIABLE military suppliers since diplomatic relations were established between the two countries in 1994. *SP's Aviation* takes a look at some key military technologies available with Israel's leading defence and aerospace companies

IAI, BIG BOY OF ARMS INDUSTRY

IAI, the fountainhead of Israel's defence and aerospace industry, has been at the forefront of India-Israel military cooperation since diplomatic relations were established between the two countries in 1994.

After making a beginning with tactical Unmanned Aerial Vehicles (UAVs) Searcher and Heron in India, it has been closely involved with programmes of strategic importance, including the Ballistic Missile Development programme for which it provided the Green Pine radar, AWACS by mating its ELW 2090 Phalcon radar on to a Russian Il-76 heavy lifter, the Barak point missile defence system for Indian warships followed by the more capable MRSAM for which it provided the radars, launchers and fire control systems.

IAI continues to be poised for the next stage in unmanned aerial systems (UAS) and anti-missile systems.

Strategic UAVs

Heron TP represents the Medium Altitude Long Endurance (MALE) UAVs capability which has so far been wielded only by the Americans. It can fly persistent missions for up to 30 hours at a height of 45,000 feet, remotely directed for multiple missions through a secure satellite communication (SATCOM) link.

While its publicly pitched as "a robust and combat proven system for complex intelligence, surveillance, target acquisition and reconnaissance (ISTAR) over any terrain, in any weather conditions", the word on the street is that this drone has a combat version, making it the only available non-American UCAV. The manufacturer confirms that its strategic UAVs can carry "various payloads".

PHOTOGRAPH: IAI

INNOVATION IS THE KEY

"**THE IMPORTANT TAKE AWAY** from the Israeli Aerospace and Defence Industries is that in the first instance, to be successful in this regime on the global scene, size of the nation is not relevant. Also, that innovation is the key to the route of development and Israel has always promoted both innovation and technology. The one notable feature that stands out in the Israeli innovation system, is the way that Israel accepts failure and also that failed entrepreneurs are not stigmatised.

The dynamism, pioneering spirit and constant pursuit of excellence and innovation truly make Israel the original 'start up nation'. And this is an important lesson apart from many others that India needs to learn from Israel." SP

—Air Marshal B.K. Pandey (Retd)

IAI brings four decades of experience in building unmanned systems, which have accumulated 1.7 million operational flying hours over mountains, deserts, and seas, into its MALE UAVs, which represents a different league in unmanned combat systems.

A range of loitering munitions including the Harop and Harpy provide multiple options to destroy enemy targets including radars through the self-destruct flight mode.

Battlefield Missile Shield

The Barak ER extends the range of the proven naval and land-based anti-missile system to 150 km, providing the theatre anti-missile capability in a networked environment.

This advanced air and missile defence system provides an integrated solution for multiple and simultaneous aerial threats – including cruise missiles – from different sources and ranges.

The induction of the Barak systems by India began with the Barak-1, which provides a short-range shield to its warships against enemy missile attacks. The MRSAM, jointly developed with the DRDO and also known as the Barak 8, extends India's battlefield missile interception range to 70 km. This capability corresponds to that of the Barak LRAD. The MRSAM is now part of essential weaponry for all major newly-built Indian warships.

Increasing the range of a missile shield for Indian military assets to 150 km would appear a natural progression.

Ballistic Missile Defence System

The Arrow Weapon System (AWS) was the world's first operational, national, multi-tier Anti-Tactical Ballistic Missiles (ATBM) defence system. With its Arrow 2 and Arrow 3 interceptors, this modular air defence system detects, tracks, intercepts and destroys incoming Terminal Ballistic Missiles carrying a range of warheads to provide a ballistic missile shield to population centres and strategic assets.

IAI claims new technologies in the Arrow 3 interceptor to intercept and destroy the newest, longer-range weapons of mass destruction.

The Arrow 3 integrates into the Arrow Weapon System (AWS) in conjunction with the Arrow 2 interceptor to enable upper-tier multiple engagement capability.

Many observers reckon that India's own multi-tier Ballistic Missile Defence System could be inspired, at least in part, from the Arrow, which also uses the Green Pine radar as its backbone.

RAFAEL, PROVEN IN COMBAT

The game-changing success of the Litening targetting pod for laser-guided bombing in the Kargil War and the recent use of the SPICE 2000 precision glide bombs in the Balakot air strike have made these weapon systems part of Indian military folklore. The manufacturer of both these systems, Rafael Advanced Defence Systems, can take a bow for providing the right solutions for India's pressing military requirements. Rafael is an armaments giant whose precision strike products and technologies are wielded by leading militaries across the world.

Smart Bomb Family

SPICE Family (250, 1000, 2000) of stand-off, autonomous, air-to-ground weapon systems that attack targets with pinpoint accuracy and at high attack volumes, without depending on GPS navigation in GPS-denied environments. These use a unique scene-matching technology for precise bombing at ranges of up to 100 km.

A unique Artificial Intelligence enabled Automatic Target Recognition and Moving Target Detection homing capability based on electro-optic scene-matching algorithms make the SPICE highly accurate and lethal, besides making it assurance of low collateral damage.

Targeting Pods

The Litening is the world's most used target designation pod, with 1,900 units in use by 27 air forces across the world. Rafael teamed up with ELTA to equip the Litening with a synthetic aperture radar (SAR) to give it a quantum leap in the stand-off capability domain. This addition of SAR to an electro-optical pod solves the problem of target identification when flying above clouds, giving it true day-night, all weather capability. The pods are equipped with a laser designator, and laser marker for joint missions, as well as an optional Data Link for stand-off ranges.

Litening is operational on over 25 types of aircraft, including the F-16, F-15, F/A-18, B-2, Jaguar, Typhoon and the Gripen, besides the Sukhoi-30, Mirage 2000, MiG-21 and 27 and the LCA.

The Reccelite is an advanced pod, and termed a game changer. Besides the addition of the SAR as in the Litening to overcome the challenge of cloud cover, the Reccelite consists of an airborne ISR pod, a wideband digital Data Link, and a Ground Exploitation System which enables the mission plan to be uplinked during flight to hit targets of opportunity. It also provides high resolution images for a full aerial intelligence picture, making it a real-time multi-spectral reconnaissance system. It is used by 10 air forces, and is operational on F-16, F/A-18, Gripen, Heron 1, Jaguar, Reaper, Tornado, and Typhoon.

Air-to-Air & Air Defence Missiles

The Python-5 is a full sphere advanced air-to-air Infra Red missile and air defence missile. The I-Derby is a moderately priced Beyond Visual Range, SDR seeker, new generation air-to-air and air defence missile.

Air Defence

The SPYDER SR/MR family of short and medium range air defence systems using the I-Derby and Python-5 missiles. This commonality between the use of the missiles for air defence and on front-line fightersis one of the main features and advantages of the system. SPYDER is in operation with five militaries, including the IAF.

The Drone Dome is a Counter-Unmanned Aerial System (C-UAS), designed to detect, track, and neutralise drones either by jamming their communication or destroying them using a high-powered laser. Recently supplied to the British forces, it is being offered to Brazil for a range of civil applications.

Precision Tactical Missiles

The SPIKE family of multi-purpose, multi-platform tactical

ISRAEL AEROSPACE INDUSTRIES: THE JOURNEY SO FAR...

1953
IAI is established as the Governmental Institute for Aviation, or Bedek Aviation Company. Its focus is on aircraft maintenance and overhaul.

1955
Bedek is accredited by the Civil Aviation Authorities in Israel and the US Federal Aviation Administration (FAA) as an authorized repair station.

1959
IAI begins to move from purely service, to design and manufacture of aircraft and advanced land and seaborne systems.

1964
IAI develops its first missile, the Gabriel, for sea-to-sea applications. The upgraded version is still in service with navies around the world.

1967
ELTA Electronics Industries Ltd. is established as wholly-owned subsidiary of IAI. It later evolved into ELTA systems Ltd.

1968
IAI enters the business jet market, purchasing the rights to the 1121 Jet Commander from North America Rockwell.

1969
The Arava - the first indigenous aircraft to be fully designed, manufactured and licensed in Israel - takes flight. 103 of these aircraft were produced.

1970
The first fighter aircraft manufactured in Israel, the Nesher, takes flight. 61 were built and five of these are still operational.

1972
Golan Industries is established as a division of IAI. Today, it specializes in the manufacture of crashworthy seating for aviation and military vehicles.

1975
Israel's first home-grown fighter bomber, the Kfir, developed and manufactured by IAI, enters service with the Israeli Air Force.

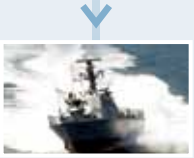
1979
IAI's first operational small unmanned aircraft, the Scout, enters air force service, remaining in operation until the early 1990s.

1988
Israel's first reconnaissance satellite, the Ofek 1, launched, making Israel the 8th nation to achieve an indigenous launch.

1990
The first in a family of anti-ballistic missiles, the Arrow 1, is tested. The upgraded and revamped Arrow 3 was operational in 2017.

1991
The Barak, a naval vessels defence system, is tested. Currently operated by Chile, India, Israel and Singapore.

1994
The Heron MALE UAV completes its first flight. It is currently serving over 20 global leading customers.



1996
IAI's cutting-edge high-speed patrol boat, the Super Dvora, goes into commission with the Israeli Navy.

2005
The G150 midsize business jet model is certified by the FAA. 120 units were built before production ceased in 2017.

2006
The first successful flight is completed of the largest indigenous unmanned reconnaissance aircraft, the Eitan, also known as the Heron TP.

2012
IAI's ground-based multi mission radar (MMR) becomes fully operational. One of its main missions is as a firing control radar for various defence systems, including the Iron Dome.

2015
The Barak 8 successfully completes its operational testing by the Indian Navy.

Source: IAI website

(LEFT) SPIKE ER WEAPON SYSTEM FROM RAFAEL; (RIGHT) DISPLAY AND SIGHT HELMET SYSTEM (DASH) FROM ELBIT SYTEMS.

missile systems address a range spectrum between 150m and 30 km. Over 30,000 SPIKE missiles have been sold to 31 nations, and over 5,500 fired in tests and combat. The Indian Army also recently ordered the first lot of SPIKE, man-portable missiles. It is being offered for arming the Fennec and Panther helicopters.

ELBIT, AVIONICS GAME CHANGER

Elbit Systems, Israel's largest defence electronics company, is a global leader in avionics and airborne equipment. It operates in the areas of aerospace, land and naval systems, command, control, communications, computers, intelligence surveillance and reconnaissance (C4ISR), unmanned aircraft systems (UAS), advanced electro-optics, electro-optic space systems, electronic warfare suites, signal intelligence (SIGINT) systems, data links and communications systems and radios.In 2019, Elbit Systems purchased the night vision business of Harris Corp of the US for a reported $350 million.

DASH III Helmet Sight & Display

Its much talked about technology is the Display & Sight Helmet System DASH III and cueing system, which enables a combat pilot to aim air-to-air and air-to-ground weapons to a target merely by looking at it. This is a key differentiator in dogfights or close combat situations.

The concept goes beyond the head-up displays (HUD) on a pilot's visor. This provides the pilot with situation awareness, an enhanced image of the scene, and allows him to direct weapon systems to the direction his head is pointing towards. Applications which allow cuing of weapon systems are referred to as helmet-mounted sight and display (HMSD) or helmet-mounted sights (HMS).

Before the availability of HMSDs, pilots had to align the aircraft to shoot at a target. An HMSD allows a pilot to simply point his head at a target, designate it to a weapon, and fire. The DASH series was first introduced in conjunction with the Python 4 missile in the early 1990s. It was the first such system globally.

Enabling Choice of Missiles

This technology enables incorporation of diverse missile and weapon systems on to an aircraft without seeking changes in the airborne radar. In India's case, this technology increases its options for acquiring airborne weapons beyond the country from which the aircraft has been acquired.

Elbit's avionics and HMD is reported to be part of the India Specific Enhancements in the Rafale fighter contract. It has also been involved with the avionics suites of the Sukhoi-30MKI and India's Light Combat Aircraft (LCA) Tejas. Elbit HMDs are even reported to have enabled the integration of Russian Beyond Visual Range (BVR) missiles on to the IAF's Mirage 2000 fleet, when European solutions were no available. It is also central to the IAF's plan to standardise short-range missiles across various fleets, and could make the integration of MBDA ASRAAMs possible on to the Su-30MKIs.

The DASH III also features in the upgraded MiG-21 BISON, one of which shot down a Pakistan Air Force F-16 on February 27, the first time ever that an F-16 was shot down in combat. Elbit has also supplied Apache Aviator Integrated Helmets for the US Army helicopter fleet. Other popular Elbit technologies include the Anvis Head-up Display, the HeliC3om integrated and digital C3 and mission management system. The first civilian use of HMD on aircraft was the Elbit SkyLens HMD on ATR 72/42 airplane.

There are many other companies in Israel's defence and aerospace manufacturing sector that are doing a stellar job, working on leading technologies and developing world class products. Israel, a very small country, has gradually and determinedly developed one of the largest aerospace and defence complex which has become the benchmark for self-reliance and aspiration for many countries to follow. SP

Israel, a very small country, has gradually and determinedly developed one of the largest aerospace and defence complex which has become the benchmark for self-reliance and aspiration for many countries to follow.

PHOTOGRAPHS: RAFAEL, ELBIT SYSTEMS

ISRAELI AEROSPACE AND DEFENCE INDUSTRIES — FORGING AHEAD!

Israeli aerospace and defence industries are clearly neck on neck in the race for development of technology and are taking technology to new heights

ON THE GLOBAL SCENE TODAY, ISRAEL, THOUGH A TINY NATION, has an extremely well developed aerospace and defence industry which covers both military and commercial domains. The defence industries are in the state-owned public sector as also in the private sector. The state-owned public sector companies include Israel Aerospace Industries (IAI), Rafael and Israeli Military Industries (IMI). The private sector has a large number companies of which the market leader is Elbit Systems.

IAI a company wholly owned by the Government of Israel, is the nation's prime aerospace and aviation manufacturer. The company manufactures aerial systems for both the military and civilian use. The company was founded in 1953 as Bedek Aviation Company and the individual responsible for initiating the move to set up the company, was Shimon Peres, the then Director General of the Ministry of Defence. The founder of the company and its first President was Al Schwimmer who had just 70 employees under him. Today, the company has over 16000 employees in its rolls.

The first aircraft that Bedek Aviation Company manufactured was the twin-jet trainer of French design, the Fouga Magister, renamed as the Tzukit. This aircraft served as the trainer aircraft for the Israeli Air Force for five decades. It was also employed in the six-day Arab-Israeli war of 1967 for battlefield support missions. The first aircraft to be fully designed and built by IAI, was a transport aircraft named as Arava. It took three years to develop and got airborne for the first time in 1969.

After the arms embargo by France at the beginning of the Arab-Israeli war of 1967, IAI began developing its own fighter aircraft 1968. This platform was a derivative of the Mirage V and was named as the IAI Nesher which entered service in 1971, in time for the Yom Kippur War. The Nesher was followed by the IAI Kfir that entered service with the Israeli Air Force in 1975. The IAI Kfir was exported to a number of countries including Colombia, Equador and Sri Lanka.

With the aim of diversifying its business, IAI entered the business aircraft market, the first product being the Astra which flew for the first time in 1985, was certified by the FAA and delivery to customers began in 1986.

The other major player with the Government of Israel in the domain of aerospace is Rafael Advanced Defence Systems Ltd or Rafael. This Israeli defence technology company was founded as Israel's National R&D Defence Laboratory for the development of weapons and military technology within the Israeli Ministry of Defence. Rafael is well known for developing and manufacturing multi-layered defence systems against rockets and ballistic missiles. A well known system produced by Rafael is the Iron Dome that is designed to intercept short-range rockets. It has been proved in operations in the Gaza strip achieving a success rate of 90 percent in neutralising rockets launched against Israel. The other defensive system is the David's Sling that is designed to intercept rockets with a range of 70 to 250 km. The company has plans to enhance the capability of this system by increasing the range at which it can intercept incoming missiles. This system is also capable of intercepting cruise missiles.

Rafael continues to be engaged in design, development and manufacture of advanced weapon systems for the Israel Defence Forces as also for customers abroad. These innovative weapon systems pertain to land, naval and air warfare as also space. The company focuses on Electronic Warfare, Command, Control, Communications, Computers and Intelligence systems, training and simulators, armour and precision-guided weapon systems. One ready example of Rafael's ability to develop an advanced weapon system is the "Spice" family of smart bombs, the Spice 250 gliding bombs that are carried by combat aircraft of the Israeli Air Force. The Spice 250 that has a stand-off range of 100km, can be loaded with 100 optional targets in a given area. With the image-matching sensor, the Spice 250 provides very high accuracy levels with CEP as low as three metres. Rafael is now developing a sixth generation air-to-air missile as well.

Elbit Systems and its subsidiaries operate in aerospace, land and naval systems, command, control, communications, computers, intelligence surveillance and reconnaissance, unmanned air systems, electro-optic space systems, electronic warfare suites, airborne warning systems, ELINT systems, data links and military communications systems. The company upgrades existing military platforms, develops new technologies for defence, homeland security and commercial aviation applications. The company provides a range of support services, handles aircraft upgrades, advanced avionics, helmet-mounted systems, head-up displays, digital maps, mission computers, aerial reconnaissance systems and guided munitions systems. Its pilot helmet was selected for the American Lockheed Martin F-35 stealth fighter. The company is a major supplier of unmanned air systems.

Israeli aerospace and defence industries are clearly neck-on-neck in the race for development of technology. The Israeli companies are taking technology to new heights and in some areas, they are well ahead of their competitors across the world. SP

— By Air Marshal B.K. Pandey (Retd)

TACTICAL HERON JOINS IAI/MALAT'S UAS STABLES

IAI'S MALAT HAS EXTENDED THE HERON FAMILY OF UNMANNED Aerial Systems (UAS), adding a lighter weight variant optimized for tactical operations. The new tactical Heron offers the Heron capabilities customers have already become accustomed to, in terms of size, weight, robustness, and operational flexibility matching tactical operations.

The T-Heron can fly at a maximum speed of 120 kmph, climb to a maximum altitude of 24,000 feet and remain on a mission for 24 hours. With a maximum takeoff weight of 600 kg, less than half the weight of the Heron I, the T-Heron can carry a useful weight of 180 kg, supporting multiple sensors for reconnaissance and intelligence surveillance and ongoing surveillance missions. On each mission, T-Heron can carry few payloads, including radars, EO/IR, SIGINT, COMINT, along with broadband datalinks, operating in line-of-sight and over a satellite terminal, supporting the simultaneous download of information from all payloads. Maintaining a cruising altitude of 21,000 ft, the T-Heron can use long-range EO/IR payloads looking 100 km deep across borders. This capability is unique to the T-Heron of all tactical UAS, providing valuable intelligence while remaining at standoff range from the enemy's air defense.

The platform features a highly efficient design for tactical ISR missions. The retractable forward landing gear clears the view for the EO/IR and radar sensors, while placements for COMINT/SIGINT antennae are located on the wingtips and booms to minimize obstruction and maximize antennae separation for optimal performance. Wing-mounted pods carry additional electronic sensors or expendable payloads such as markers or lifeboats on search and rescue missions.

The T-Heron uses a 70 per cent downscaled Heron I design. With 10-metre wingspan and low center of gravity placed well within the large, rectangular payload bay, the T-Heron provides a robust, flexible platform carrying internal and external payloads to meet different payload configurations supporting various missions. The wings are reinforced and fitted with hardpoints supporting external carriage. The new variant is designed and built as a certifiable UAS, in compliance with STANAG 4671 standard. Addressing all the Standard's criteria, T-Heron uses a FAR33 certified Rotax 912iSC aviation engine, and fully redundant safety-critical systems including power distribution, flight control, and communications. The aircraft has an integral 'pilot window,' using a tail-mounted panoramic camera and provisions for deicing ensuring flight safety at high altitude and in icing conditions. To enable sharing the airspace with civilian aircraft, T-Heron also carries IFF/TCAS for identification and collision avoidance.

The T-Heron is designed to operate in extreme environmental conditions, including high altitude, a temperature range of -40 to +55°C, crosswinds of 20 knots, and rain flow of 50mm per hour.

IAI's standard iUCS mission control systems are used to conduct the mission from the ground. The iUCS supports all mission phases, platform, and payloads. The modular iUCS supports different configurations for tactical deployment in armored vehicles or shelters, maritime, and airborne platforms. The system is designed to operate with a single crewmember or stack several iUCS to support larger crews on more complex missions. The T-Heron's payloads can also be controlled from portable terminals, using the two-way remote terminal (RVT).

Built to operate from short, unpaved surfaces, T-Heron relies on integral brakes, power, and cooling, and is independent of specialized ground support equipment such as arresting cable, power and cooling carts. The system is stored and transported in two standard 20-foot ISO air-deployable containers, requiring two vehicles for field operation. On tactical deployment, the system can minimize the support crew, utilizing the Heron family 'Long Runner' remote operation feature, forward-deployed T-Heron can be controlled remotely from a control center, performing all functions, including takeoff, landing, and taxing without relying on local support teams. IAI offers customers a full logistics package, providing flight line, intermediate and depot level (D level) maintenance and support, ensuring complete independence.

The T-Heron joins the successful, combat-proven Heron Family, the leader of IAI MALAT's Unmanned Aerial Systems stables. Boasting more than 17,00,000 operational flight hours in the service of 50 countries worldwide, IAI's Heron Family now includes four variants. These variants perform missions spanning 24 hours and more, carry payloads of 180 kg to 1 tonne, support Intelligence, Reconnaissance and Surveillance (ISR) operations in strategic, operational, tactical missions, as well as Homeland Security (HLS), Search and Rescue (SAR), Maritime Patrol, and Anti-Submarine (MP/AS) missions. SP

—SP's Correspondent

PHOTOGRAPH: IAI

"LOCKHEED MARTIN WILLING TO PARTNER INDIA ON LCA TEJAS MK-II AND AMCA"

F-21 offer is complementary to the LCA, campaign lead **Dr Vivek Lall** tells **Vishal Thapar** of ***SP's Aviation*** in an exclusive interview

THE WORLD'S LARGEST DEFENCE CONTRACTOR DOES NOT believe that the Indian Air Force (IAF) commitment to the indigenous Light Combat Aircraft (LCA) kills the market for foreign single-engine fighters in India. While pitching the F-21, Lockheed Martin is also offering technical assistance to increase the production rate of the LCA.

With its F-21 campaign pegged on a robust 'Make in India' proposition, Lockheed Martin brought 26 Tier-I suppliers for the F-16/F-21 to its Indian Suppliers Conference at New Delhi recently to dialogue with 70 shortlisted Indian companies in the run up to the Multi-Role Fighter Aircraft (MRFA) competition. Excerpts from the interview with **Dr Vivek Lall**, Vice-President Aeronautics Strategy and Business Development, Lockheed Martin:

***SP's Aviation* (SP's): What sort of Transfer of Technology (ToT) and partnerships are you discussing at the Indian Suppliers Conference?**

Dr Vivek Lall (Lall): We've got 26 of our Tier-I suppliers here as well as over 70 Indian companies here. This three-day conference will have more than 540 meetings. The whole idea is to continue to build the aerospace ecosystem here in India, so that once we're are tasked to build a fighter, we have all the building blocks here, and the suppliers vetted, not just us but also our Tier-Is.

So, there's a ToT and the indigenous content bit. ToT is dependent upon ability to absorb technology. It's a range of ToT being looked at depending upon the component.

At our two JVs at Hyderabad, we have delivered 108 C-130 empennages, over 150 Sikorsky S-92 cabins. The 5,000+ precision components that go into the Sikorsky cabins have all been indigenised. That shows the progress made in indigenisation.

As we announced last year, all future wing production of the F-16s, regardless of the outcome of the competition, will be done jointly with the Tatas. The manufacture of the prototype wing has already started. Once the EoI (Expression of Interest) is out (for the MRFA programme), we'll be able to better define what ToT is included in our offer. The intent is to create an indigenous fighter platform here in India just like we've done in other countries. We're proven to do that.

SP's: What attributes are you looking for in potential partners?

Lall: Our Strategic Partner for the F-21 programme is Tata. We've had a great experience with 2 JVs with Tata in producing the C-130 empennage and the S-92 cabins over the last 10 years for the global supply chain and as we've fleshed out that eco system, what we're looking for obviously is performance, capability, quality, cost schedule but above all, a vision of the roadmap of technology absorption as well as take not just the present project but what's the future and put this in the wrapper of integrity and shared common values.

In any robust ecosystem, the founding blocks are those of MSMEs and so it's very imp for them to come up the value chain in terms of their expertise. And as we go over 200 companies in India. we've found that expertise, pockets of excellence, in terms of being able to deliver. So we look at the same attributes across the supply chain. We've incubated a lot of start-up companies for the Tata programme.

PHOTOGRAPH: LOCKHEED MARTIN

We have a dedicated team performing Indian supplier onsite assessments. We have found over 200 companies in India. The Suppliers Conference is an opportunity for Tier 1s to have a dialogue with Indian industry.

SP's: You seem fairly committed to the Tatas. But the Indian Strategic Partner (SP) for the F-21 programme has to be selected by the Government of India. Are you flexible in your choice of a partner for this competition?

Lall: We have two very successful JVs with the Tatas over the last 10 years. All future wing production for the F-16s globally will also be done with the Tatas. For the F-21, we are strategic partners. But obviously, as the competition plays out, we will be following the Government of India guidelines and we will be compliant.

SP's: Under this SP model, foreign OEMs are allowed to be part of multiple bids. Should Tata not make it, would you be willing to go with another group?

Lall: That's a hypothetical question. But suffice it to say we've talked to over 200 companies in India and it (Tata) is our Strategic Partner along with an entire ecosystem. That's why we're doing these supplier conferences (together).

SP's: How would the entry of public sector undertakings (PSU)s in a SP programme change the competition?

Lall: These are hypothetical questions. We'll wait for the EoI and RFP to come out and comply with Government of India guidelines, but suffice it to say that we're interfacing with both private and public companies. In fact, recently, we've signed an MoU with BEML. That's a public company, and so, we're talking across the spectrum, and once the requirement becomes clear from the Government of India, we will comply with them.

Here (at the Suppliers Conference), we have both public and private companies present. I think to have a robust eco system, it's less about the ownership and more about the capability to perform and absorb technology, and those are some of the factors that go into a successful programme that could be public or private. Whatever drives competitiveness in Indian industry is good.

SP's: While this is indeed a hypothetical question, your competition, Boeing has already tied up with the public sector HAL, which is the only one which has existing manufacturing facilities. Doesn't that put you at a disadvantage?

Lall: No, I think we have the best 'Make in India' offer on the table. We have the most robust package. Not only that, if you look at the sustainment market, we have the world's largest fighter ecosystem: 3,000+ fighters flying. So, when you look at the after sales support and the MRO market, the scale that we have to offer India to plug into this eco system is completely unmatched by any competitor.

SP's: The IAF has a big commitment to the indigenous LCA Tejas fighter. Will this kill the market for foreign single engine aircraft in India?

Lall: The LCA is an air defence asset. The F-21 is deep penetration strike aircraft. And so, the operational profiles are different. The F-21 flies farther. It stays on station longer, and it gets there faster. So, it has a very different operational profile. The F-21 is very complementary to the Tejas. We've also extended our support, in any way possible, to the Government of India on the LCA.

SP's: Does that mean there's potential for (international) cooperation on the LCA Mk-II?

Lall: Absolutely. We're willing to work with the Government of India whether it's the LCA Mk2 or AMCA.

> "The LCA is an air defence asset. The F-21 is deep penetration strike aircraft. And so, the operational profiles are different. The F-21 flies farther. It stays on station longer, and it gets there faster. So, it has a very different operational profile. The F-21 is very complementary to the Tejas. We've also extended our support, in any way possible, to the Government of India on the LCA"

SP's: What's your offer?

Lall: Depends upon their requirements. And we will work with the Government of India. Everything is caveated to US Government approval and what the Government of India desires a foreign OEM to assist with.

SP's: You are a seasoned observer of the Indian scene. What could be the possible areas of cooperation on the LCA or AMCA? What could be on offer?

Lall: We have a system called the Auto GICAS, which is a collision avoidance system. It can be integrated on to the Indian platform. It's a unique system that saves lives. It's able to correct when the pilot is disoriented. The other technical expertise can be in terms of increasing production rates and capacities.

SP's: Lockheed Martin's earlier offer of the F-16 in the MMRCA programme was not found technically compliant. How is the F-21 offer different in capability terms?

Lall: So, there are several unique aspects to the F-21. One is that it's the only aircraft in the world with dual refuelling – both the probe and drogue and the boom refueller. The second aspect is that it has an India unique EW suite. The third thing is that it has 40 per cent more weapon carrying capability through the triple rail launcher that we have on the F-21. Then, we've added an aft dorsal fin which gives increased growth capacity to it, and finally it's got a modern cockpit.

SP's: Will the F-21 lead in to the F-35?

Lall: To start with, the F-35 would be a government-to-government conversation. I can't really comment on that. But having said that, Lockheed Martin is the only company in the world which has two operational fifth-generation fighters. All these technologies are leveraged for the F-21 platform. SP

(The full text of this interview has been uploaded on our websites: www.sps-aviation.com and www.spsmai.com)

INDIA SUCCESSFULLY DEVELOPS ITS FIRST BEYOND VISUAL RANGE AIR-TO-AIR MISSILE

Successful indigenous design and development of the Astra coupled with Akash Mark 2 SAM, signposts the maturity of the Indian weapons industry in mastering cutting-edge missile technologies

INDIA HAS SUCCESSFULLY DEVELOPED THE 'ASTRA', ITS FIRST all-weather Beyond Visual Range (BVR) Air-to-Air Missile (AAM) and leaped into a group of few nations that have a weapon system of this capability and performance. The Defence Research and Development Organisation (DRDO) initiated concept studies for developing an indigenous AAM in the 1990s. The Government of India sanctioned the Astra project in March 2004 with a budget of ₹995 crore. The Hyderabad-based Defence Research & Development Laboratory, a Missile System laboratory under the DRDO was designated as the design and development (D&D) agency for the Astra missile. During its development, the design of Astra missile went through several iterative changes for improving its control, guidance and propulsion systems as also reduction in weight. Ground testing of the Astra began in December 2012 and the missile was cleared for captive flight trials on the Su-30MKI combat platform in April 2013. The first Astra missile was launched from the Su-30MKI in May 2014 and so far, 27 missiles have been test fired to ascertain and validate its performance.

The Astra is designed to carry 15 kg high explosive pre-fragmented warhead, which is activated by a Radio Proximity Fuse. The missile has good Electronic Counter-Countermeasure (ECCM) to enable unconstrained operation in an Electronic Countermeasure (ECM) environment. The Astra Mark 1, which successfully completed the trials recently, has a maximum head-on launch range of 100 km, a speed of 4.5 Mach and is cleared for launch up to an altitude of 20 km (66,000 ft). The Astra could be launched either by the mother aircraft or fired in buddy mode. The extensive and rigorous trials have successfully validated the Astra missile's warhead capability, its maximum launch ranges against both head-on and manoeuvring targets, its long-range target engagement capability, clear missile-separation at supersonic speeds, launch under high 'g' forces and multiple missile launches at multiple targets. During the trials, the Astra missiles were launched across the entire flight envelope of the Su-30MKI and all of these successfully engaged, hit and destroyed all assigned manoeuvring and non-manoeuvring aerial targets besides meeting with all mission objectives.

After launch, the Astra initially uses 'Inertial Mid-Course Guidance' through a secure data-link from the mother aircraft followed by 'Active Radar Homing' from its seeker head for terminal guidance. To absorb delays in the development process of the indigenous active radar seeker, it was decided to develop the Astra missile with Russian 'Agat 9B1103M' active radar seeker for terminal guidance. The entire D&D of Astra including the firing trials up to the year 2017, were conducted with the Russian active radar seeker. The decision to use the Russian seeker for D&D and trials phases was a very prudent one as it enabled concurrent engineering and development of both, the missile and its active radar seeker independently. The Indian Ku-band active radar seeker was developed by DRDO and is now fully functional. This form-fit indigenous seeker has now been installed on all Astra missiles. Thus, today India has its first indigenously developed BVR AAM with indigenous active radar seeker. The Indian Air Force (IAF) being satisfied with Astra's development and performance, is in the process of placing initial order for 100 missiles in the prototype version on the manufacturer Bharat Dynamics Limited (BDL). Induction of this wapons system into the IAF will commence later this year.

Performance and kill ranges of the Astra Mark 1 is slightly better than the BVR AAM currently employed by our adversaries. The Astra is already integrated on the Su-30MKI and the IAF will certainly integrate this weapons system with the upgraded Mirage 2000, the MiG-29, light combat aircraft Tejas and may be with the Rafale jets that are expected to start arriving in September this year. The Astra is the first Beyond Visual Range, Air-to-Air Missile that is designed, developed and manufactured by the Indian aerospace industry. Its successful induction will greatly boost the BVR combat capability of the IAF.

After the successful development of the Astra Mark 1, the first BVR AAM, the IAF and DRDO have already started the process to develop Astra Mark 2, an improved version of Astra Mark 1. The Astra Mark 2 will have a head-on launch range of over 100 km along with the capability for ejector launch. It is certain that the Astra Mark 2 will be one of the best BVR AAM capable of outperforming all current BVR AAM except the European Meteor that is coming with the 36 Rafale fighters.

Successful indigenous design and development of the Astra BVR AAM coupled with Akash Mark 2 SAM, signposts the maturity of the Indian weapons industry in mastering cutting-edge missile technologies as also helping the 'Make in India' campaign and reinforcing national defence. SP

The author is a former Deputy Chief of the Air Staff and Air Officer Commanding-in-Chief of Central Air Command, IAF.

ILLUSTRATION: ANOOP

BARNES WALLIS (1887-1979)

When the World War II started, Wallis felt that the best option to defeat the Germans would be a strategic bombing campaign against their industrial heartland

THE FAMOUS "DAM BUSTERS" RAID CONDUCTED BY THE Royal Air Force (RAF) during the World War II was a major highlight of Allied air operations. A crucial personality behind the scenes was Barnes Wallis, a scientist, engineer and inventor who designed the unique bouncing bombs that breached Germany's Möhne and Edersee dams, causing catastrophic flooding in the Ruhr valley and also damaged the Sorpe Dam.

Barnes Neville Wallis was born on September 26, 1887, in Derbyshire, England. At 17, he joined an engineering works as an apprentice. Meanwhile, he learned much of the theory needed for his career. In 1913 an opportunity arose for him to work on airship design and then aircraft design. He was an important figure in developing the airships of the 1920s and early 1930s. His key achievement was a geodesic structure for the Vicker's R.100 airship that was later adapted for conventional aircraft. It gave planes a better chance of survival even after a direct hit from anti-aircraft fire.

In 1922, when the painfully shy Wallis was 35, he met his charming 17-year-old second cousin, Molly Bloxam. Her father first strictly forbade their friendship, but relented enough to permit them to correspond on the subject of mathematics, which Molly was grappling with for her university science course. During the next three years, the pair exchanged over 250 letters, with Wallis patiently explaining the intricacies of calculus and trigonometry, interspersed with more tender topics, and encouraging her to excel in mathematics. On Molly's 20th birthday, Wallis mustered up enough courage to propose to her and they were married in April 1925.

When the World War II started in 1939, Wallis felt that the best option to defeat the Germans would be a strategic bombing campaign against their industrial heartland. Referring to their power supply facilities he wrote, "If their destruction or paralysis can be accomplished, they offer a means of rendering the enemy utterly incapable of continuing to prosecute the war." The problem was the gross inaccuracy of high-level aerial bombing where less than ten per cent of bombs were expected to fall anywhere near their target. He began designing huge bombs of up to ten tonnes weight with enough explosive force to destroy large industrial targets that would otherwise not suffer greatly. Since the existing bombers could not carry such loads, he proposed a large plane which he called the "Victory Bomber".

Hydroelectric dams were attractive targets mainly because they were massive fixed structures. However, Germany's dams were well constructed and heavily defended. Any air raid would be immediately picked up on radar and neutralised by the German air defence. It was calculated that a huge amount of explosive power would be needed to breach a dam unless the explosion took place in contact with the wall. After mulling over the puzzle for some time, Wallis arrived at a solution which was to train a team of crack pilots to drop specially designed bombs with enhanced accuracy and send them in too low for radar detection.

Accordingly, he designed a bomb named 'Upkeep' that was powerful enough to break the concrete structure of a dam. After being released at ultra-low level some distance from target, the drum-shaped bomb would make a series of bounces on the water surface till it hit the dam, then roll down the dam's wall and explode at its base. Upkeep was programmed to detonate only on sinking to a certain depth. It was also designed to lag well behind the dropping bomber to prevent the attacking aircraft being damaged by the force of the explosion below. Initial tests were rather discouraging, but Wallis quickly analysed the reasons and within months, was able to produce a bomb suitable for the intended mission.

"Operation Chastise" was mounted on the night of May 16/17, 1943, by 19 Lancaster bombers of No. 617 Squadron, led by Wing Commander Guy Gibson. Due to the breached dams, at least two hydroelectric power stations, 25 bridges and 11 factories were destroyed, plus significant damage inflicted on other industrial infrastructure. Casualties on the ground were around 1,300. The bomber fleet sustained heavy losses with eight aircraft shot down and 53 of the 56 aircrew killed. Although the hardworking Germans were able to eventually rebuild the facilities, the raid provided a huge morale boost to the Allied nations that were growing weary of military setbacks.

Barnes Wallis later turned to much heavier "earthquake" bombs like Tallboy and Grand Slam. These were used against the German U-boat pens and V-weapon facilities with devastating effect. After the War, he continued working on novel aircraft designs till his retirement in 1971. He died on October 30, 1979, with Molly by his side. SP

— JOSEPH NORONHA

MODEST 6.8 PER CENT HIKE IN INDIA DEFENCE BUDGET OF $46.5 B

THE GOVERNMENT ON JULY 5 ANNOUNCED A BUDGETARY allocation of ₹3,18,931.22 crore ($46.5 billion) for Defence services as part of the overall ₹27,86,349 crore ($406 billion) Union Budget for 2019-20, marking a modest 6.87 per cent increase in India's spending on the defence services.

What brought some cheer to defence planners was Finance Minister Nirmala Sitharaman announcement of an exemption of Customs duty for imported military equipment. The Ministry of Defence later claimed that this exemption would effectively boost the military modernisation budget by ₹25,000 crore ($3.6 billion) over the next five years.

Of the three armed forces, the Indian Air Force and Navy have higher allocations for modernisation than for recurring Revenue expenditure on fixed costs. At ₹39,302.64 crore, the IAF gets the lion's share of the Capital allocation for modernisation. It's Revenue Budget is ₹29,601.69 crore. The Navy gets ₹23,156.43 crore under the Capital head against a Revenue allocation of ₹22,211.71 crore. But this favourable Capital-Revenue ratio is reversed by the Army's huge allocation of ₹1,41,501.19 crore for fixed costs, mainly on account of its huge manpower bill. Against this, the Army's Capital allocation for modernisation stands dwarfed at ₹29,461.25 crore. SP

—Vishal Thapar

IAF GETS ITS FIRST APACHE ATTACK HELICOPTERS AT HINDON

THE FIRST FOUR OF THE 22 AH-64E APACHE ATTACK HELICOPTERS being acquired for the Indian Air Force (IAF) arrived at the Hindon airbase near Delhi on July 27.

The arrival of the world's most lethal helicopter gunship coincided with the 20th anniversary of the Kargil War of 1999, when India sorely missed an attack helicopter capable of operating at high-altitudes while evicting Pakistani intruders from mountain tops. A Mi-17 doubling up as a weaponised helicopter was shot down with a Pakistani Stinger in the early stages of the war.

India signed a $1.4 billion contract with the US in 2015 for 22 Apache helicopters with an options clause for six more. The first AH-64 was handed over to the IAF at Mesa in Arizona, US, in May this year.

Within a few days of the delivery of the first lot of four Apaches on July 27, some more will reach Hindon. After the initial induction procedures, these gunships will be based at Pathankot. The IAF will move half of the fleet to Jorhat in Assam after all 22 are received next year. SP

—Vishal Thapar

MTCR RELAXATIONS: RANGE OF BRAHMOS INCREASED TO 450 KM

THE RANGE OF INDO-RUSSIAN BRAHMOS SUPERSONIC CRUISE missiles has been increased to 450 km after the lifting of restrictions on India under the Missile Technology Control Regime (MTCR), *SP's* has learnt from highly-placed military sources. The earlier range was 290 km.

This increases India military options for launching surprise precision cross-border attacks, and beefs up the stand-off buffer for the BrahMos, which is very difficult to detect and intercept in terrain-hugging flight mode at speeds up to 2.8 Mach.

BrahMos is an Indo-Russian joint venture, with Russia providing critical parts and technologies. The MTCR placed an embargo on supply of missiles and missile technology to non-members of this export-control regime in cases when the range exceeded 300 km. This restriction was lifted after India became a full member of the MTCR in 2016. SP

—Vishal Thapar

PAK OPENS AIR SPACE AFTER NEARLY 5 MONTHS OF CLOSURE

PAKISTAN HAS RE-OPENED ITS AIRSPACE AFTER THE CLOSURE of around five months for all civilian traffic on July 16. This step comes as a removal of the ban that was imposed on Indian flights, not allowing them to use the majority of Pakistan's airspace since the renowned Balakot air strikes.

On February 26, Pakistan had entirely closed its airspace. This was after the Indian Air Force (IAF) carried a daring predawn airstrike on a Jaish-e-Mohammad (JeM) terrorist training camp in Balakot on the same date. Since the IAF's airstrike, of the total 11 routes, Pakistan had only opened two routes passing through the southern region of the neighboring country. However, the ban laid down by Pakistan along its eastern border with India was continued. It was on July 16 that Pakistan's Civil Aviation Authority (PCAA) issued a notice to airmen (NOTAM) stating that "with immediate effect Pakistan airspace is open for all type of civil traffic on published ATS (air traffic service) routes".

Pakistan's Federal Minister for Aviation Ghulam Sarwar Khan disclosed on July 18 that PCAA has suffered a loss of ₹8.5 billion, owing to air space restrictions since February 2019 in the wake of Indian transgress; but this closure hit Indian Aviation drastically hard as compared to Pakistan; he apprised the loss margin of India as almost double.

Indian airlines were majorly affected too due to the airspace closure that led to increased flight time for passengers as well as huge fuel costs for the airlines. SP

—Ayushee Chaudhary

QUICKROUNDUP

ELBIT SYSTEMS

It is reported that Israeli defence company Elbit Systems could possibly net a $180 million deal for drones with the Philippines Army. Sources apparently say, that the deal, which includes the Hermes 900, Hermes 450, Skylark 1 and Skylark 3 UAV, could possibly be signed in the near future. The Philippine Army will use these UAVs for intelligence gathering, patrols, and border defence missions.

GA-ASI

General Atomics Aeronautical Systems has won a $22 million modification for support services on the Gray Eagle UAV for procurement of performance based logistics support services. The Gray Eagle is a 3,600-pound, 28-foot-long drone with a 56-foot wingspan. It has a range of 2,500 nautical miles and a ceiling of 25,000 feet. Work is expected to be completed by June 30, 2020.

GENERAL ELECTRIC

General Electric has won a $24.9 million modification by the US Naval Air Systems Command to procure 72 F-414-GE-400 engines for the F/A-18 Super Hornets of the Navy and the government of Kuwait. 24 will be for the US Navy and 48 for Kuwait. Kuwait will underwrite 69 per cent of the figure or $17.5 million, under the Foreign Military Sales (FMS). Work is scheduled to be finished in December 2020.

ISRAEL AIR FORCE

Israel has taken the first step towards replacing its old Boeing-707 aerial tankers by submitting a Letter of Request to the US Government, for the acquisition of two new Boeing KC-46 aerial tankers. The request is for the acquisition of two aircraft with an option for the future acquisition of an additional six. Israel Defence reports that aerial refueling tankers are vital for the Israel Air Force to extend its long strategic reach.

LOCKHEED MARTIN

Lockheed Martin has launched the latest version of an advanced visualisation and training tool for Apache AH-64 sensor system maintainers, called Rely3D which is an interactive suite of applications that supports Apache aircraft maintainers with M-TADS/PNVS virtual guides, 3-D animations, wiring diagrams and more. The advanced tool is aimed at reducing maintenance time on the Apache M-TADS/PNVS system.

NEW ZEALAND

New Zealand's Ministry of Defence has released its Defence Capability Plan 2019 on June 11, 2019, outlining the investment priorities for the New Zealand Defence Force to 2030. Top priority is the replacement of the five Hercules transport aircraft. The preferred option for this replacement is the C-130J-30 Super Hercules, which is a four-engine turboprop military transport aircraft by Lockheed Martin.

INDIA TESTS INDIGENOUS HYPERSONIC TECHNOLOGY DEMONSTRATOR VEHICLE

India launched an indigenously-developed Hypersonic Technology Demonstrator Vehicle (HSTDV) on its maiden test flight from a base off the Odisha coast on June 12, 2019. The HSTDV is an unmanned scramjet demonstration vehicle that can cruise up to a speed of mach 6 and climb up to an altitude of 32km in 20 seconds. A successful test of the HSTDV could boost the development of a hypersonic cruise missile, the Brahmos II, which is currently under development with Scramjet technology.

SAAB GRIPEN AND GLOBALEYE FOR FINLAND

Saab has announced that its offer to deliver its Gripen to Finland also entails two GlobalEye Airborne Early Warning and Control (AEW&C) aircraft. Saab's GlobalEye is a multi-role AEW&C solution that can detect and track airborne and surface targets on land as well as on the sea. Saab's proposal comprises 64 Gripen aircraft of which 52 are single-seat Gripen E and 12 are dual-seat Gripen F, as well as two GlobalEye AEW&C aircraft. Finland is planning to take a final decision on procurement of these platforms in 2021.

SIKORSKY CONTRACT FOR PRESIDENTIAL HELICOPTERS

Sikorsky has won a $542 million firm-fixed price modification from the US to produce six VH-92A Presidential Helicopters. Under the Low Rate Initial Production (LRIP) Lot 1, Sikorsky will begin deliveries of six VH-92A helicopters in 2021. The remaining production aircraft will be delivered in 2022 and 2023. The contract also provides spares and training support. The VH-92A is the military variant of the Sikorsky S-92. It is currently under development and will replace the Marine One US Presidential Transport Fleet.

SPECIAL OPERATIONS HELICOPTERS FOR US SPECIAL FORCES

The US Special Operations Command has awarded Boeing a $194.2 million delivery order modification to procure six renew-build and one new-build MH-47G rotary-wing aircraft. The MH-47G is the special operations variant of Boeing's CH-47 Chinook multi-role, heavy-lift helicopter used by the US Army Special Operations Aviation Command. The CH-47F/MH- 47G modernisation programme includes a mix of remanufactured and new aircraft, will help the aircraft remain in the US Army fleet at least through the 2030s. The current modification will sustain US Special Operations Forces (SOF) heavy assault, rotary-wing aircraft and mitigate the impact of the MH-47G aircraft availability in light of increased SOF operational demands.

SHOW CALENDAR

13–15 August
LABACE
Congonhas Airport, São Paulo, Brazil
https://labace.com.br/en/

22–24 October
NBAA BUSINESS AVIATION CONVENTION & EXHIBITION (NBAA-BACE)
Las Vegas Convention Center, Henderson Executive Airport, Las Vegas, NV, USA
http://www.nbaa.org/events/bace/2019

LITENING 5 AND RECCELITE XR AIRBORNE TARGETING PODS

It has been reported that Israel's Rafael together with IAI's Elta Systems will upgrade the Litening 5 and Reccelite XR all-weather stand-off airborne electro-optic targeting pods with a synthetic aperture radar imagery intelligence payload, Jane's reports. The Litening 5 is a high-resolution multi-sensor targeting pod, incorporating an upgraded 1.2K x 1.2K large aperture forward-looking mid-wave infrared and a short-wave infrared. The fifth-generation of the targeting pod is now capable of targeting from long range, enabling strike aircraft to employ guided weapons from standoff range without relying on external support. Reccelite XR is a multi-spectral, multi-role, real-time standoff reconnaissance system that consists of an airborne pod, a wide digital datalink and a ground exploitation station.

APPOINTMENTS

AIRPORTS AUTHORITY OF INDIA (AAI)

Regulator Airports Authority of India has approved the temporary appointment of Anuj Aggarwal, Member (HR), as Chairman AAI, effective August 1, 2019. He holds the post of Chairman AAI as 'additional charge' for a period of three months or until further orders, whichever is earlier.

ATR

With effect from August 1, 2019, David Brigante, 59, has been appointed as Senior Vice President, Programmes and Customer Services of ATR. He will be reporting to the Chief Executive Officer, Stefano Bortoli.

DASSAULT AVIATION

Dassault Aviation has appointed Carlos Brana as Executive Vice President, Civil Aircraft. He succeeded Olivier Villa, who retired on July 1, 2019.

DIRECTORATE GENERAL OF CIVIL AVIATION

The Appointments Committee of the Cabinet has approved the appointment of Arun Kumar, Additional Secretary and Financial Advisor, Ministry of Civil Aviation, as Director General in the Directorate General of Civil Aviation in the rank of Additional Secretary.

GULFSTREAM

To expand its European sales team, on June 20, 2019, Gulfstream Aerospace Corporation announced the appointment of senior functionaries to two new positions as under:

- Chris Edwards as Regional Vice President of Sales for Northern Europe, covering the United Kingdom, Ireland, the Netherlands and Scandinavia.
- Alessandro Scarpellini as Regional Vice President of Sales for Southern Europe, including Switzerland.

LOCKHEED MARTIN

The Board of Directors, Lockheed Martin has approved the following appointments:

- Frank St John as Executive Vice President of Rotary and Mission Systems.
- Scott Greene as Executive Vice President of Missiles and Fire Control.

US ARMY CONTRACT FOR SIKORSKY

The US Army Contracting Command has awarded an FMS contract to Sikorsky for $15 million contract modification to procure the Post Green DD250 aircraft support, storage and maintenance for UH-60M aircraft for the Saudi Arabian Ministry of the National Guard. The UH-60M is a variant of the Black Hawk medium-lift utility helicopter. The UH-60M has multi-mission capabilities and features a new airframe, advanced digital avionics and a powerful propulsion system. In July 2017, Sikorsky secured a $3.8 billion contract from the US Department of Defence to deliver 142 UH-60M helicopters for the US Army and 115 helicopters to the National Guard of Saudi Arabia. Estimated completion date is April 30, 2022.

APACHE CONTRACT FOR BOEING

Boeing has won a $47.7 million contract from the US Army for modification in support of the Apache Attack Helicopter AH-64E production line and Apache Longbow Crew Trainers. The deal provides Version-6/Improved Drive System enhancement cut-in. The AH-64E is a variant of the twin-turboshaft Apache Attack Helicopter. The AH-64E features improved digital connectivity, the Joint Tactical Information Distribution System, more powerful T700-GE-701D engines with upgraded face gear transmission to accommodate more power, capability to control UAVs and improved landing gear.

JAPAN'S ALOS-3 SATELLITE

Japan is planning to put an experimental infrared sensor on board the ALOS-3 satellite which it plans to launch into space orbit next year. The mounted sensor will enable Japan to acquire its own early warning satellite capability to detect ballistic missiles launched from North Korea and elsewhere. The image sensor that uses tiny semiconductor particles is said to be able to detect infrared rays in two wavelength bands. ALOS-3 is an Earth observation satellite that continuously observes the global land area and orbits at an altitude of 669km.

QUICKROUNDUP

The New Zealand Government said it has made progress in its programme to procure Boeing P-8A Poseidon maritime patrol aircraft from the US government. New Zealand agreed to procure four P-8A aircraft in July 2018. It said at that time that the acquisition - including training systems, infrastructure and introduction into service costs would total $1.5 billion. Delivery of the first P-8A to the RNZAF is expected by April 2023.

PHILIPPINE AIR FORCE

According to the local media, Philippines will take delivery of the A-29 Super Tucano in February 2020. Philippine Air Force(PAF) Commander, Lt GenRozzano Briguez speaking during the PAF's 72nd founding anniversary said that the Super Tucanos "will be a game-changing platform, which will perform surface strike support to ground troops". They are expected to support the remaining North American Rockwell OV-10 Bronco attack aircraft being used by the PAF in strike missions.

RUSSIA

The Russian Defencse Ministry has confirmed the purchase of 76 Su-57 multirole fighter jets under a contract with Sukhoi Company at the Army 2019 Forum. The jets will be supplied by 2028. In May 2019, President Putin had said that Russia planned to purchase 76 SU-57s instead of 16 by 2028 without increasing the price. The SukhoiSu-57 is the country's first indigenously designed and built fifth-generation stealth fighter jet.

TAIWAN

Lara Seligman from Foreign Policy Magazine has reported that Taiwan's request to buy F-16V jets was expected to move forward this month, but the Ministry of Foreign Affairs has said that the request is still being reviewed by the US. According to the article, although the deal for 66 F-16 Block 70 jets has been stalled, it is expected to move forward before the US Congress begins its traditional recess next month.

US

The US State Department has approved a possible FMS to Morocco for continuing sustainment support to its current F-16 fleet for an estimated cost of $250.4 million. Morocco had purchased the F-16s in 2011. In March 2019, the US State Department has also approved the upgrade of 23 Royal Moroccan Air Force F-16 Block 52+ to the F-16V configuration for an estimated cost of $985.2 million.

USAF

The US Air Force has awarded AAR Supply Chain a $210 million ceiling contract for contractor logistics support for the Afghanistan Air Force. The contract will provide the Afghanistan Air Force with full C-130H contractor logistics support to include maintenance and repair, as well as on the job training for local Afghan nationals. Work is expected to be completed by January 29, 2025.

BALANCE STRATEGIC RELATIONSHIPS

Success in the domain of foreign policy is unlikely unless a carefully crafted and discreet balance is maintained in relationships with the leading global players.

By **AIR MARSHAL B.K. PANDEY (RETD)**

INDIA HAS FORMALLY CONCLUDED A DEAL WITH RUSSIA TO purchase five batteries of the Russian S-400 Triumf long range air defence missile system valued at $5.4 billion. This deal which is of significance for India has unfortunately triggered off tensions between the United States (US) and India. It was signed in Delhi on October 5, 2018, after a meeting between Russian President Vladimir Putin and Prime Minister Narendra Modi during the 19th Russia-India Summit.

During the Cold War era, even though India was not an ally, the nation was tethered almost entirely to the then Union of Soviet Socialist Republic (USSR) which practically was the only source for the acquisition of military hardware for the Indian armed forces. Despite its proclaimed non-aligned status, for some reason, the US viewed India to be in the Soviet camp and never conceded to its request to provide military hardware especially combat aircraft as well as offensive and defensive missile systems. All that the Indian Air Force (IAF) received from the US after the Sino-Indian conflict of 1962 was a fleet of 79 old C-119 Fairchild Packet twin-piston engine transport aircraft that had been deployed in support of US forces during the war in Korea and was to be retired from service. With the breakup of the USSR in 1991 and the consequent emergence of a uni-polar world, India was now free to explore markets in the West for a wider range of options and possibly for weapon systems of better quality and capability. As expected, India veered away from Russia and looked to the US for military hardware and acquired a variety of military transport aircraft some of which are already in service with the IAF while other platforms are to be delivered in the near future. The list includes the C-17 Globemaster III strategic airlift aircraft, the C-130 tactical transport aircraft, P-8I Poseidon maritime patrol aircraft, AH-64E Apache attack helicopters, CH-47F Chinook heavy-lift helicopters, MH-60R naval helicopters, Predator B armed drones and the NASAMS II air defence system. Since the time India developed this new relationship with the US, around $15 billion worth of military hardware has already been procured and delivery of platforms and systems against orders valued at $10 billion are expected to begin in the near future.

Further, action is also in hand to acquire 114 medium multi-role combat aircraft for the IAF for which the Lockheed Martin F-16 is a strong contender. In fact, Lockheed Martin has carried out modifications to the F-16 and rebranded the platform as F-21 specifically for India. Meanwhile, the Indian Navy is to procure 57 carrier-capable twin-engine fighter jets for the aircraft carrier Vikrant currently under construction at the Cochin Shipyard. The twin-engine F/A-18 from Boeing would be a strong contender.

The dynamics of strategic relationships among the nations in the Indo-Pacific region are indeed complex. The US has always regarded India as a significant player in this region; but was unable to develop a meaningful strategic relationship during the Cold War era. However, since 1991 when the year the Cold War ended and liberalisation of the Indian economy took place, there has been changes in the equation between India and the US. In 2007, Prime Minister Abe proposed the Quadrilateral Security Dialogue, also known as the 'Quad', under which India was to join a formal multilateral dialogue with Japan, US and Australia. Although the US was in support of this plan, it did not takeoff as Australia saw it as an unwarranted step to antagonise China. India too had similar apprehensions. In the year 2016, the US took a major step forward to strengthen the strategic relationship with India by declaring her a "Major Defence Partner". This certainly facilitated further procurement of military hardware by India from the US. On July 2, 2019, the US Senate passed a legislation elevation India to be on par with NATO allies of the US.

On account of the growing ties with the US, procurement of military hardware from Russia had practically stopped. Two major projects undertaken by India involving the development in collaboration with Russia, of the fifth-generation fighter aircraft and the medium transport aircraft to replace the ageing fleet of An-32 aircraft, were abandoned leading to much consternation in Russia. It would have subsequently dawned upon the political leadership in India that in the long term, it would be politically and strategically unwise to stop procurement of military hardware altogether from Russia that had stood by India for over half a century. As for the Russian aerospace industry, driven possibly by commercial considerations, it has begun to supply military hardware to Pakistan, something that it had not done in the golden years of relationship with India.

Procurement of the S-400 air defence missile system from Russia, despite threats of sanctions from the US, therefore, appears to be a positive step and in the right direction on the part of India. In the context of the prevailing strategic environment, success in the domain of foreign policy is unlikely unless a carefully crafted and discreet balance is maintained in relationships with the leading global players. SP

PHOTOGRAPH: WIKIPEDIA

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