

# SP's aviation



AN SP GUIDE PUBLICATION



SHARP CONTENT FOR A SHARP AUDIENCE

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VOL 22 ISSUE 8 • 2019

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FAILURES ARE PILLARS OF SUCCESS



50 YEARS OF  
EMBRAER

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50  
YEARS OF  
APOLLO 11

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Subscription/Circulation

Annual Inland: ₹1,200 • Foreign: US\$320

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*In 1969, a giant leap was taken by science,  
humankind and aerospace exploration when  
for the first time in history men walked on the  
surface of the Moon.*

*(Art Work by Russ Arasmith, NASA)*

**COVER DESIGN BY**

*SP's team*



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**“One small step for man, one giant leap for mankind” - Commander Neil Armstrong as he became the first man to walk on Moon after the Apollo 11 Lunar Module Eagle landed on July 20, 1969.**

**THE BIGGEST AEROSPACE EVENT THAT HAS MADE HEADINGS**

this year and being celebrated across the globe is the 50 years of Moon landing. National Aeronautics and Space Administration (NASA) also is celebrating the 50th anniversary of the very first landing of a human being on the surface of the Moon. National Aeronautics and Space Administration (NASA) also is celebrating the 50th anniversary of the very first landing of a human being on the surface of the Moon. The mission to the Moon designated as Apollo 11, was launched on July 16, 1969, by a Saturn V rocket from the Kennedy Space Centre on Merrit Island in Florida, USA. Commander Neil Armstrong and lunar module pilot Buzz Aldrin were the American crew that landed the Apollo 11 Lunar Module Eagle on the Moon on July 20, 1969. The momentous event was described by Commander Neil Armstrong as “One small step for man, one giant leap for mankind,” has been and will always be remembered. The successful mission also fulfilled a national goal set in 1961 by President John F. Kennedy to land a man on the Moon before the end of the decade. This issue of *SP's Aviation* carries a detailed and comprehensive coverage by Ayushee Chaudhary, of this achievement five decades ago. Of special interest would be the interview with Brian Odom, the historian at NASA's Marshall Space Flight Centre in Huntsville, Alabama.

Another major venture that celebrated its 50th anniversary is the Brazilian aircraft manufacturer Empresa Brasileira de Aeronáutica or Embraer for short. It was in August 1969 that the government of Brazil took a decision to set up a facility to design, develop and manufacture aircraft both in the military and civilian segments of the global market. In 1994, Embraer was privatised and now it is ranked as the third-largest manufacturer of commercial aircraft in the world. This issue of *SP's Aviation* includes the journey of Embraer over the last 50 years.

Closer home, the operational capability of the Indian Air Force (IAF) received a huge shot in the arm with the formal

induction of the first batch of eight (from a total of 22) AH-64E Apache attack helicopters contracted with Boeing of the US. This platform is regarded as one of the most modern, versatile and lethal rotary wing weapons platform in the world today. The induction ceremony held at IAF Station, Pathankot on September 3, 2019, where one squadron of the Apache attack helicopters will be based, was presided over by Air Chief Marshal B.S. Dhanoa, Chief of the Air Staff, IAF. This issue of the magazine carries a report on the event by Vishal Thapar.

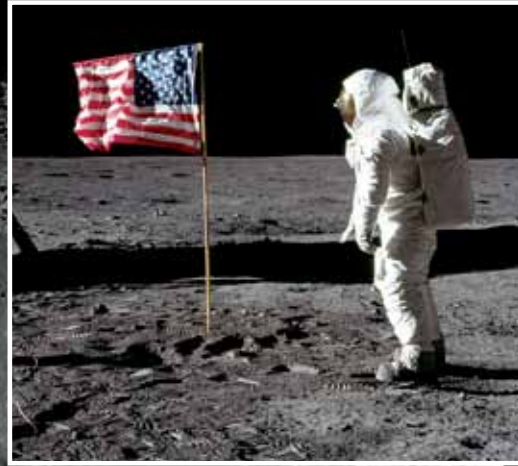
Exactly a week after the meeting in Paris between Prime Minister Narendra Modi and Emmanuel Macron, President of France, the Indian and French National Security Advisers met in New Delhi on August 29 to push forward the proposals to scale up Defence and Strategic sector cooperation between the two nations. A widely reported proposal relates to the French offer for a second batch of 36 Rafale fighter jets at an estimated cost of about Euro six billion. The first contract for 36 Rafale jets was concluded in September 2016 and the aircraft are expected to begin arriving in September this year. A report by Vishal Thapar on the interaction between the Indian and French officials has been included in this issue of the magazine.

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

Jai Hind!

**JAYANT BARANWAL**  
PUBLISHER & EDITOR-IN-CHIEF





(LEFT) NEIL ARMSTRONG, MICHAEL COLLINS AND BUZZ ALDRIN; (RIGHT) BUZZ ALDRIN POSES FOR A PHOTOGRAPH BESIDE THE DEPLOYED US FLAG DURING AN APOLLO 11 EXTRAVEHICULAR ACTIVITY ON THE LUNAR SURFACE.

# HALF-A-CENTURY INTO MAN'S MAIDEN ENCOUNTER WITH THE MOON'S 'MAGNIFICENT DESOLATION'

In 1969, a giant leap was taken by science, humankind and aerospace exploration when for the first time in history men walked on the surface of the Moon, Earth's only natural satellite. We at SP's look back at what the mission was and how 50 years of this historic feat are being celebrated.

*By* **AYUSHEE CHAUDHARY**

PHOTOGRAPHS: NASA



**IT IS NOT VERY OFTEN THAT YOU LOOK UP TO THE MOON** shining bright in the night sky not to find expressions in its craters but to know that a fellow human is actually taking a walk on its surface. However, in 1969 this surreal moment was indeed experienced by an estimated 650 million people. 50 years ago, humankind had a literally out of the world experience in its truest form when men landed on the lunar surface leaving footprints to be etched forever.

As writes NASA (National Aeronautics and Space Administration), "On July 20, 1969, humans walked on another world for the first time in history, achieving the goal that President John F. Kennedy had set in 1961 before Americans had even orbited the Earth". When the President announced this, not enough was even known about the lunar surface and its geology yet eight years hence, the 'giant leap' was successfully taken. As NASA managed to accomplish this challenge with the Apollo programme, a way was paved for expeditions beyond our home planet. Apollo was the NASA programme that resulted in American astronauts' making a total of 11 spaceflights and walking on the moon.

The lunar landing mission with a crew aboard and a safe return back to the Earth included dodging a lunar crater and boulder field, exploring the area around the lunar landing site, collecting soil and rock samples, setting up experiments, planting an American flag and leaving behind medallions and a commemorative plaque signed by President Richard M. Nixon and the three astronauts that stated, "We came in peace for all mankind."

Seated atop the three-stage 363-foot rocket, Saturn V, at Launch Complex 39A at the Kennedy Space Center, Apollo 11 astronauts Commander Neil Armstrong, Command Module Pilot Michael Collins and Lunar Module Pilot Edwin "Buzz" Aldrin were ready to reach the moon.

#### THE MISSION

The central focus of the mission remained to perform crewed landing on the moon's surface and a safe return to the Earth. But there were other objectives too that included exploration of the lunar surface by the crew as well as the lunar module called the Eagle.

On July 16, 1969, Apollo 11 was launched from Cape Kennedy into an initial Earth-orbit of 114 by 116 miles.

On July 18, Armstrong and Aldrin climbed from the Command Module, Columbia, to Eagle and the next day came the first lunar orbit insertion maneuver.

On July 20, both the astronauts entered the Lunar Module again and 'at 100 hours, 12 minutes into the flight, the Eagle undocked and separated from Columbia for visual inspection'.

Post 102 hours, 45 minutes, the Eagle landed in the Sea of Tranquility region of the moon. Occurring almost one-and-a-half minutes earlier than scheduled, the touchdown included a powered descent that ran a mere nominal 40 seconds longer than preflight planning due to translation maneuvers

to avoid a crater during the final phase of landing. Almost four hours later, Armstrong appeared from the Eagle and deployed the TV camera for the transmission of the event to Earth.

At about 109 hours, 43 minutes into the flight, history was made as the first human footstep on the lunar surface was taken by Armstrong while he echoed, "That's one small step for a man, one giant leap for mankind." He was followed by Aldrin 20 minutes later and about half an hour later the astronauts had a word with President Nixon by telephone link.

NASA also recalls that commemorative medallions bearing the names of the three Apollo 1 astronauts who lost their lives in a launchpad fire and two cosmonauts who also died in accidents were left on the moon's surface. A one-and-a-half-inch silicon disk, containing microminiaturized goodwill messages from 73 countries, and the names of congressional and NASA leaders also stayed behind.

Armstrong and Aldrin spent 21 hours, 36 minutes on the surface of the moon and about two-and-a-half hours from this entire time was invested in the EVA (Extra-vehicular Activity) phase. After spending one hour, 33 minutes on the surface,

Aldrin who aptly described his surroundings while on the moon as a 'magnificent desolation' re-entered the Eagle, followed by Armstrong, 41 minutes later.

The ascent stage engine was fired at 124 hours, 22 minutes and the trans-Earth injection of the CSM (command and service modular) began on July 21. Following this, the astronauts slept for about 10 hours. 44 hours after leaving lunar orbit, the re-entry procedures were initiated on July 24.

After a flight of 195 hours, 18 minutes, 35 seconds – about 36 minutes longer than planned – Apollo 11 splashed down in the Pacific Ocean on July 24, 1969, 13 miles from the recovery ship USS Hornet. Because of bad weather in the target area, the landing point was changed by about 250 miles.

As reported by NASA, in a post-flight press conference, Armstrong calls the flight "a beginning of a new age," while Collins talks about future journeys to Mars. Over the next three and a half years, 10 astronauts followed in their footsteps.

#### CELEBRATIONS THEN

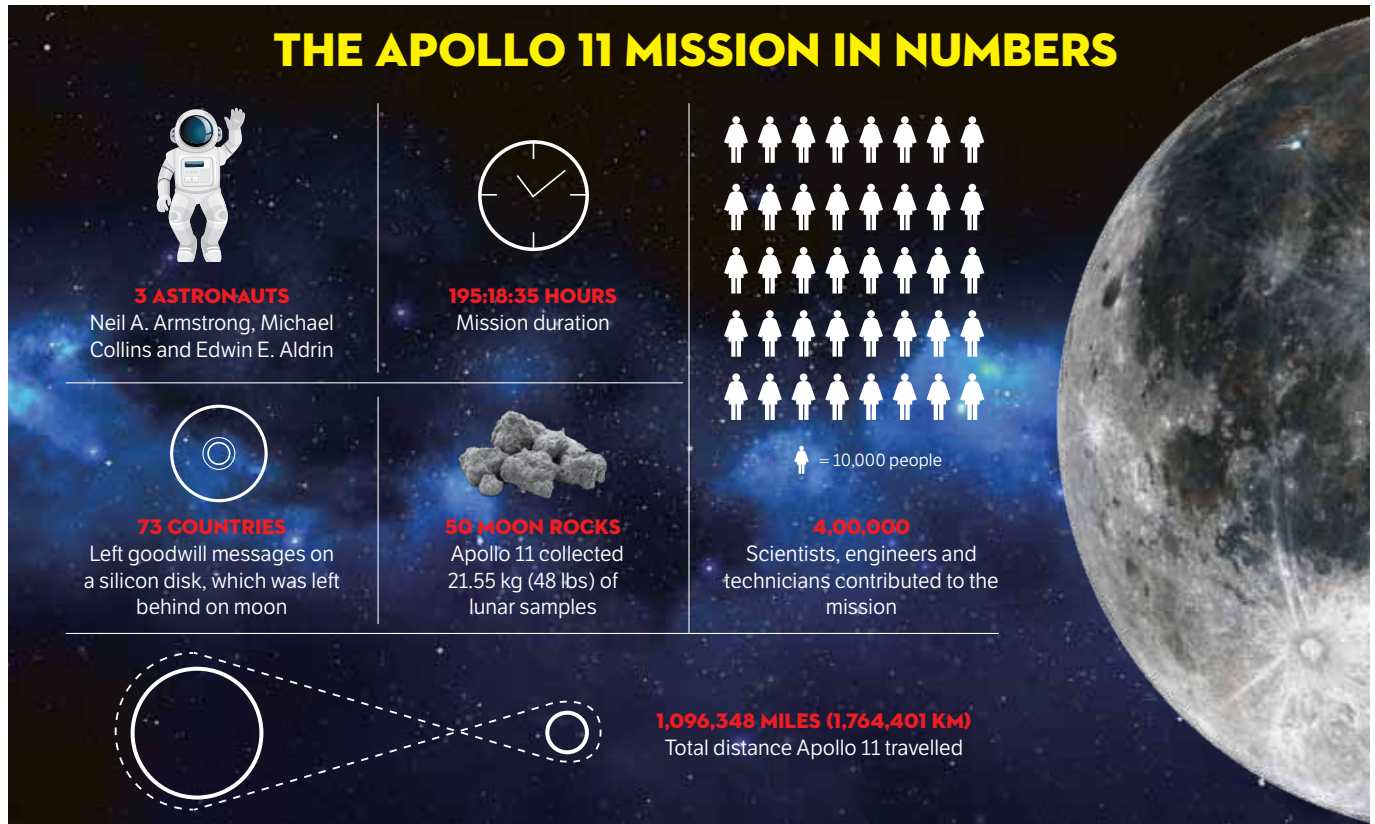
The samples collected from the moon were carefully analysed in quarantine and the astronauts were straight kept in quarantine for 21 days in a Mobile Quarantine Facility (MQF) to avoid any 'moon plague'. They had collected 47 lbs of moon rocks and had taken 166 pictures.

On July 26, Hornet arrived on Pearl Harbor with the astronauts in the MQF and Columbia to be greeted by as many as 2,500 well-wishers. President Nixon welcomed home the Apollo 11 astronauts, sealed in the MQF and spoke to them through telephone. The celebrations within the NASA mission control room were unmatched but were shared by citizens around the globe with news-



**At about 109 hours, 43 minutes into the flight, history was made as the first human footstep on the lunar surface was taken by Armstrong while he echoed, "A small step for a man, a giant leap for mankind". He was followed by Aldrin 20 minutes later and about half an hour later the astronauts had a word with President Nixon by telephone link.**





Source: Space Centre Houston

papers, radio, televisions, and documents, flooded with this historic mission.

### 50 YEARS LATER, CELEBRATIONS CONTINUE

From Google Doodle bringing the world's attention to 50 years of the historic Apollo 11 mission, to public screenings and real-time videos of the mission to many other events that included exhibits, speakers, demonstrations, interviews, documentaries and a host of fun activities, the entire world celebrated 50 years since the first human set a foot on Earth's sole natural satellite, the Moon.

- NASA states that the logo for the 50th anniversary of Apollo 11's moon landing gives a nod to the past with a few elements borrowed from the original Apollo programme emblem, and a glimpse into the future with a graphic depiction of NASA's vision for the next half-century of deep space exploration. The arc through the word "Apollo" represents Earth's horizon, as seen from a spacecraft.
- NASA offered various interesting opportunities to celebrate the 50th anniversary of the historic Apollo 11 Moon mission with the agency and look to the future of exploration on the Moon and Mars.
- NASA and the Smithsonian National Air and Space Museum hosted the Apollo 50 Festival, a free three-day event on the National Mall in Washington that comprised of exhibits, speakers, demonstrations and a host of fun activities. NASA researchers, scientists, and engineers showcased NASA's newest technologies and innovations during the festival.
- Throughout the summer, Cherry Crest Adventure Farm in Lancaster, Pennsylvania, is presenting an Apollo-themed

corn maze for tourists.

- The US Postal Service celebrated the 50th anniversary of Apollo 11 and humanity's first steps on the Moon with two Forever stamps.
- NASA and the Armstrong Air & Space Museum in Wapakoneta, Ohio, built to honor Wapakoneta's own Neil Armstrong and other Ohioans in space exploration marked the anniversary with festivities including a 5k and 10k Run to the Moon with NASA astronauts, space inflatables, interactive STEM activities, rocket launches, and more.
- NASA also collaborated with the Kennedy Center for the Performing Arts in Washington and the National Symphony Orchestra Pops on a musical and visual tribute to the 1969 Moon landing
- New York's Metropolitan Museum of Art displayed over 170 photographs along with related drawings, prints, paintings, films, video art, astronomical instruments, and cameras used by Apollo 11 astronauts.
- Omega, whose watches were used during the actual mission by the astronauts unveiled limited-edition Speedmaster watches that celebrate 50th anniversary of the Moon landing.
- Airbnb Invited travelers to stay at five "interstellar" homes around the globe—for just \$11 a night. From a handmade rocket ship in New Zealand to a futuristic flying saucer in the United Kingdom, these one-of-a-kind dwellings promise to transport voyagers to a galaxy far, far away—without having to leave Earth.
- A Hawaii brewer apparently used space dust to create an 'Interplanetary Ale'.



EXCLUSIVE

# RELIVING MAN'S MAIDEN MOON MISSION

**Brian Odom**, the historian at NASA's Marshall Space Flight Centre in Huntsville, Alabama talks to *SP's Aviation's* Ayushee Chaudhary about Apollo 11 and more.

**SP's Aviation (SP's):** It is well established that Apollo 11 was and will always remain historical. What according to you as a historian, makes history?

**Brian Odom (Brian):** It indeed is and shall remain historical. Even 5,000 years from now, people will look back and will always remember that was the century in which we went to another heavenly body. So it being an incredible first, a monumental first certainly makes it historical. It was also such a leap forward that it changes our own identity of who we are as people, and marks that we could become a space bearing civilisation to go beyond. In that way, it is a key turning point in history, a turning point where you take the next big escalation like an industrial revolution or a scientific revolution. This revolutionary idea of going to another heavenly body really wrapped up to make it an exceptionally important historic event.

**SP's:** We had Apollo missions back to back and then there has been a gap until now with Artemis. What do you think sort of created that gap? Were we waiting for something or were there more questions and therefore a pause to analyse better before moving further?

**Brian:** I think it was several reasons but again it was the way we went first time on the Moon. The idea of just landing on the Moon, collecting material and returning to Earth, that's not a sustainable method, and you cannot continue doing that. Also, it's too expensive, so you had to wait and what we were doing in the meantime was learning more about getting to space, about being in space, about producing energy, and developing new technologies. Right now we are at a critical breaking point where with developed technologies and through explorations like we have done on Mars with robots, landers

and now with industry partners, you have sort of reached this critical mass where the time is right and the correct key technologies are there. There are now enough resources as well that we can now go back to the Moon in a different model, a model that can build around sustainability, about sustaining that presence on Moon and to me that's what has been built over the last 50 years. We have learnt so much and now is the time for us to go apply those lessons to the Moon, learn new lessons on the Moon and then go to Mars to learn more lessons.

**SP's:** 'The primary objective of Apollo 11 was to complete a national goal set by President John F. Kennedy on May 25, 1961: perform a crewed lunar landing and return to Earth.' Was the President's statement the major trigger point, a major push that probably made this mission happen a little earlier in time?

**Brian:** Oh yes without a doubt his statement was a motivation because that's something that you have to have. Just how your Prime Minister, Mr. Narendra Modi, has spoken about space exploration and sending humans in space. The idea that you commit and make this a national goal and then follow this goal with committed national resources to it, is what gives such missions a boost. The plans were already in place but that's what Kennedy did, he talked about it and committed. When you receive that kind of a commitment from the highest office, from the national government; you also receive access to that kind of resources to accomplish something as major as this.

**SP's:** But it was a good trigger for NASA to have bounced back especially after Apollo 1 accident and to become what it is today. Apollo 11 did somewhere pave the way for what NASA is today?

**Brian:** Absolutely. One of the things that as an agency and as a humanity

ASTRONAUT BUZZ ALDRIN SEEN BESIDE THE SOLAR WIND EXPERIMENT DURING APOLLO 11 MISSION





this mission did was it just highlighted that if given the resources and if we put our minds to it, there's not much that we cannot do as a species and that's why Apollo 11 resonates with this that despite not having the technologies they did it and accomplished. This will be remembered 1000 years later also as to what happens when human beings put their mind into something.

**SP's:** How crucial do you think were the missions before Apollo 11 in deciding its success, especially considering Apollo 1 accident and Apollo 11's success in less than a decade of the President's announcement?

**Brian:** Without a doubt every mission is incredibly important even Apollo 1. Apollo 1 was a horrible day, it was a huge loss but it really changed the way they saw safety. There was an effort to go back into the programme and the programme that came from the aftermath of that accident was a much better version. Then you have the Saturn V, this monstrous technological marvel that makes all this possible, the first launch Apollo 4 was a flawless launch in all three stages. But the second launch Apollo 6 was a disaster almost; you had failure at every stage and even restart was done on the orbit so while they still got to the orbit there were many things that didn't go as planned. So you continue to learn about the system, make the corrections and then go forward. Apollo 7 was a Saturn-1B, a smaller rocket but that was the first time human beings were on board in the Apollo programme. Apollo 8 was important too as it was the first time ever the humans went beyond the low Earth orbit so these three astronauts in Apollo 8 travelled to the Moon, they orbited the Moon, they took some of the most important pictures for NASA. The Earth-rise photo comes from Apollo 8 mission. For the first time humans got to see themselves in a way they had never seen before through that picture of the Earth. Apollo 9 again, you learn better about orbiting. While Apollo 10 returns to the Moon and is kind of a dress-rehearsal for the lunar landing as Apollo 10 does everything but land on the lunar surface. So by the time you get to Apollo 11, the only thing you have never done is to actually land on the Moon. That's why that was such a critical moment during Apollo 11 when Neil Armstrong sees that they are about to land on a crater that's filled with boulders, he takes control of the landing craft and tries pushing it to somewhere else. So the first time we plan to land on another heavenly body and the place we picked up to land was actually not correct so those last few moments made it all the more crucial but we did it. So you always learn.

**SP's:** It had its flavor of anxiety throughout the mission but once it happened, it has only inspired and given hopes to so many people across the globe, isn't it?

**Brian:** Exactly, when Apollo 11 landed, the world was watching. It wasn't just America, it was humanity doing something that had not been done before. Humanity could be a part of it and know its own potential. When the astronauts came back and went on a world tour, wherever they went people greeted them saying that we did it that just reassures that deep down we are all very connected in this spirit.

What we want to do is not just go there, land and then come back like the Apollo missions but to eventually by 2028 develop a permanent presence on the Moon just like we have done with the International Space Station in the past two decades.

**SP's:** What do you think has changed for space exploration since Apollo 11?

**Brian:** I think geopolitically Earth is a different place now than it was in the 1960s and we hope it continues to stay a different place than it was in the 1960s. In the 50 years from Apollo, we have learnt so much about living and working in space. Through the space shuttle programme we learned about getting to space, access to space and America is not the only one now that has access to space. You look at the Russians who had a huge role in establishing space expedition. Now India as well is up there, there's Israel too. There's a lot more to space exploration now. There's the European Space Agency, the Japanese space agency, there are so many participants now, which is a great thing. The world is a different place now but like I mentioned earlier we are going to need all the players, all the hands on deck to accomplish something like this. You cannot have people working against each other, you can't have people working in isolation from each other because these things are incredibly difficult. You have a situation like International Space Station where great science happens every day and that's like a collaboration model, not a competition model.

That's really the model which needs to dominate to be successful in the future.

**SP's:** So we are still hoping to find life on Moon or elsewhere?

**Brian:** Yes, that's one piece of it obviously. If there could be anything near to the accomplishment of landing on the Moon, it would be discovering life on the Moon because that in a way changes our own identity. To know that we are not alone in the universe would be extra ordinary, it would kind off shatter our perspectives of who we are. It's the idea to go to the Moon and the idea about the lunar South Pole as well that there could be water present there. If we can find sustainable materials, things that are so critical to our survival on the Moon, that would be a complete game changer. We can have water, we can have fuel, and we can generate oxygen. Helium-3, which is on the Moon in very large amounts, has the ability to

change the way we produce energy on Earth. It could revolutionise how we give energy, and we need to explore that more.

**SP's:** You mentioned about how all the three Apollo 11 astronauts, Neil Armstrong, Buzz Aldrin and Michael Collins are deep space advocates and held lifelong passion for space. Now there is also the movie, *First Man*, coming up. How will that rekindle more aspirations and young minds?

**Brian:** *First Man* kind off profiles Neil's life. But one of the things that's so incredible about that movie is not just portraying Neil's life but also showcasing what was it like to sacrifice and participate in such a programme. It gives an inside view and highlights that it was not just those three astronauts but also over 4,000 men and women involved in the program who sacrificed their health, and the time with their families to accomplish something so great. I believe space programmes resonate with young minds and inspire them to work harder and become a part of something so incredible, difficult yet holding great benefits. **SP**

Full interview, log on to [www.sps-aviation.com](http://www.sps-aviation.com)



THE MCMATH SOLAR TELESCOPE CIRCA 1962 (NOW REFERRED TO AS THE MCMATH-PIERCE SOLAR TELESCOPE)

EXCLUSIVE

# HALF-A-CENTURY PAST, APOLLO 11 STILL A DISCOVERY AND INSPIRATION

As the world celebrates 50 years of Apollo 11, man's first landing on the moon, *SP's Aviation* interacts with the National Science Foundation to discover some vital ways in which the organisation contributed to the mission

By AYUSHEE CHAUDHARY

**50 YEARS AGO, WITH APOLLO 11 HUMANS SET FOOT FOR THE** first time on another astronomical body, the Earth's natural satellite. The mission changed and added perspectives and dreams that need no limit, provided inspiration to thousands of young minds and continues to do so. While space travel has not become easier through these 50 years, what this half-a-century celebration marks is how much more complex yet ahead of its time the instruments used for the Apollo missions were in the 1960s, as remarks Dr Joseph E. Pesce, PhD, Programme Director, Division of Astronomical Sciences, Directorate for Mathematical & Physical Sciences, National Science Foundation, also a young child for whom missions like Apollo 11 further ignited his interests in astronomy, paving way for his career and life itself. Another important highlight that comes from missions like Apollo 11 is the technological legacy that they provide.

## PREPARING FOR THE UNKNOWN

In 1969, while the humans prepared to forge into something by far unknown and unexplored, it was a plunge into uncertainty and definitely called for excessive levels of preparations to have the best possible idea of what lay ahead for the astronauts. In this context, the National Science Foundation (NSF) played a significant role as the Apollo astronauts visited NSF's

Kitt Peak National Observatory to learn about the lunar surface. The trip that the astronauts of Apollo 11 made to the Moon might have happened only in July 1969 but in April 1964 they did have a much shorter trip to the lunar surface five years before the actual one. Apollo 11 astronauts Buzz Aldrin and Michael Collins had traveled to the Kitt Peak National Observatory near Tucson, Arizona to view the Moon through the McMath-Pierce Solar Telescope. A visitor's logbook from the time described the viewing conditions during their visit: "Seeing fair, flashes of good (Moon low.)". It was as a part of a training programme designed to familiarize Apollo astronauts with the distant destination that awaited them. The NSF-funded McMath-Pierce Solar Telescope was the most sophisticated solar telescope in the world. Completed in 1962, the telescope's great light-gathering ability and superior resolving power made it an important tool for early lunar mapping and photography which indeed played a crucial role in preparing the astronauts to some extent before their actual lunar landing. Using the solar telescope at Kitt Peak, the University of Arizona geologists collaborated with the US Geological Survey to create maps of the Moon for the Apollo programme. The astronauts were also provided with custom-made eyepieces that had been designed exclusively for the Apollo visit by the



staff of the observatory. These “astronaut eyepieces” allowed the group of astronauts to view enlarged sections of the Moon simultaneously. During April and May 1964, the three groups of Apollo astronauts visited NSF’s observatory to study the lunar surface and be trained not only as astronauts but also as scientists. This was done as a part of the requirement that NASA aspired for the astronauts to not just fulfill technical needs during their missions but to also become competent scientific observers. These visits to NSF observatory, allowed Apollo astronauts to receive training that prepared them to collect data and perform experiments on the lunar surface.

#### COMMUNICATION CORD

A very significant aspect of the 50-years-old Apollo mission was the communication that took place from the Moon and back to Earth, between the astronauts on the lunar surface to the team on Earth. Without the successful communication, we would have never heard Neil Armstrong utter, “That’s one small step for a man, one giant leap for mankind” as he became the first man to step on the surface of the Moon.

dard broadcast signal and then sent to Houston, via, satellite, landline or microwave antenna. Without radio astronomy, it would not have been possible to obtain the live images of Apollo 11. While the radio observatories are now a crucial part of pretty much all astronomical observations, Dr Joseph would hope that as humans return to Moon in 2024 with Artemis carrying the hope for settling on the moon, there might also come a time soon for observatories to be set up on the Moon itself. “It would be nice to put some observatories on Moon at some point of time. Moon would be a nice place for some radio observatories as it offers a great environment for radio astronomies and even for optical astronomy and thus ensure better astronomical observations about other astronomical bodies out there in the universe,” he said.

#### AN INSPIRATION ETCHED FOREVER

Even though Dr Joseph admits that with humans going up to the Moon and returning did give hopes for men to be soon staying longer on the Moon, the pause after the Apollo programmes washed those aspirations. But he also added that space travel



**“A take away for me from Apollo 11 was that we can do anything. It might even be an awe-inspiring goal which we might not be able to accomplish right away but if we work hard towards it we can develop the technology for it and make it happen. Don’t limit your goals and dreams, you might not be able to do it today but you surely can in the future.”**

**—Dr Joseph E. Pesce, PhD, Programme Director,  
Division of Astronomical Sciences, Directorate for Mathematical  
& Physical Sciences, National Science Foundation**

We would have seen neither Buzz nor Neil walking on the lunar surface, nor planting the flag or have any of the constant updated communication. “A worldwide network of radio antennas, not only the set-up of just that large network of dishes but also to move and transfer the large amount of that data from one telescope to other was required and NRAO played a pivotal role in that,” informed Dr Joseph. NRAO is NSF’s National Radio Astronomers Observatory. With landing humans on Moon and returning them safely, Apollo 11 was itself a complex and far-sighted mission but that was not all. The Kennedy administration wanted to have a live feed of the lunar landing and Apollo was required to send radio messages as well from the Moon. NRAO explains that through radar astronomy, the motion and distance of the Moon was known to be within about a kilometer, precise enough for an attempted landing. Radar-ranging would allow a lander to reach the lunar surface safely but radio messages were still to be delivered from the Moon and that was some task at hand. Live television was transmitted from the Moon to three ground stations, two in Australia (Parkes Radio Astronomy Sire New South Wales and Honeysuckle Creek Tracking Station Canberra) and one in California (Goldstone Tracking Facility Mojave Desert). The signal was converted to a stan-

is very difficult. “One of the probable reasons why we have not gone after the Apollo missions though we expected staying on Moon, is the difficulty and complexity of the whole process. Some might say we have lost 50 years of exploration but I’d say we have been developing technologies during that time because it is very difficult. Even though people see space travel happening quite frequently now, it still is not easy. Going to the space station in itself is difficult, let alone going to the Moon or Mars but those developments would not have occurred if it was not for missions like Apollo 11,” added Dr Joseph. He also highlighted how that is what Apollo 11 did. It not only provided scientific advancement and space expedition but made way for technology, brain power, research and an inspiration that continues to facilitate more space explorations. “A take away for me from Apollo 11 was that we can do anything. Any goal that we admit for ourselves can be reached. It might even be an awe-inspiring goal which we might not be able to accomplish right away but if we work hard towards it, we can develop the technology for it and make it happen. Certainly don’t limit your goals and dreams, you might not be able to do it today but you surely can in the future,” said Dr Joseph. SP

*To read the full story, log on to [www.sps-aviation.com](http://www.sps-aviation.com)*



THE ONE MORE ORBIT TEAM WITH GULFSTREAM G650ER IN BACKGROUND, AFTER SUCCESSFUL COMPLETION OF THEIR ROUND-THE-WORLD FLIGHT

# COMING FULL CIRCLE: POLE TO POLE IN LESS THAN 48 HOURS

To commemorate the completion of 50 years of Apollo 11, when men first landed on the moon, former NASA astronaut and a team of international aviators simultaneously broke multiple international flying records for circumnavigating the Earth over its North and South Poles

*By* AYUSHEE CHAUDHARY

**ON JULY 11, 2019, ACTION AVIATION (A PRIVATE JET AND** helicopter sales, support, and charter company based in the United Kingdom) Chairman Hamish Harding and former International Space Station Commander Col. Terry Virts broke the Round-the-World record for an aircraft flying over the North and South poles in a Qatar Executive Gulfstream, G650ER

ultra-long-range business jet. The record was successfully accomplished in the 50th year of celebrating man's first walk on the Moon. The attempt which was a tribute to the past, present, and future of space exploration, pushed the boundaries of human ingenuity just like the Apollo 11 mission did half a century ago.

PHOTOGRAPH: ONEMOREORBIT.COM



The record attempt was launched from Space Florida's Launch and Landing Facility (the former Shuttle Landing Facility) at NASA's Kennedy Space Center, which is the exact same location from where Apollo 11 launched the historic manned moon mission in 1969. Not only that the time at which the mission started on July 9 was 9:32 EDT which was also the time of Apollo 11's launch 50 years ago. The flight returned on July 11 at 8:12 am to the same Space Center after a full circle.

The record date also marks the 500th anniversary of man first circling the planet. And now, having completed the fastest ever circumnavigation of the Earth via its geographical polar ends has marked history in its own sense.

Having covered a total of 21,691 nautical miles (40,172 km), the flight completed the circumnavigation in 46 hours, 40 minutes and 22 seconds at an average speed of 465 knots (or 535 mph or 861 kmph). Collectively called as "One More Orbit", the mission has set a new record under both the Fédération Aéronautique Internationale (FAI), and Guinness World Record in the Polar Circumnavigation of the Earth Speed Record for any aircraft category.

### PAST RECORDS

The previous FAI speed record was formed over a decade ago in 2008 by Captain Aziz Ojeh in a Bombardier Global XRS. The polar circumnavigation was completed by Ojeh in 52 hours and 32 minutes, at an average speed of 444 knots (or 511 mph or 822 kmph) and existed for 11 years. One More Orbit beat this record by a margin of 5 hours and 52 minutes.

While the Guinness Record which was the fastest aerial circumnavigation of the Earth via both geographical poles was previously held by Captain Walter Mullikin who made it in a Pan Am Boeing 747SP in 1977, who had started and ended it in San Francisco. Set for 54 hours and 7 minutes at an average speed of 423 knots (or 486 mph or 783 kmph), this record stood for 42 years. Both the FAI and Guinness World Record organisation calculate the record differently, hence erasing any possibilities of disputes.

### THE CREW

The crew had estimated the mission to be done in about 48 hours but managed to finish even before their own estimation, hence displaying precision and skill of the crew and all those who were involved. The crew consisted of the following members:

- Captain Hamish Harding - United Kingdom, Action Aviation Chairman, Mission Director and one of the 4 G650ER pilots
- Colonel Terry Virts - United States, Former International Space Station commander, Space Shuttle astronaut, Soyuz astronaut and US Air Force test pilot
- Captain Jacob Ove Bech - Denmark, Pilot
- Captain Jeremy Ascough - South Africa, Pilot
- Captain Yevgen Vasylenko - Ukraine, Pilot
- Magdalena Starowicz - Poland, Flight Attendant
- Colonel Genaddy Padalka - Russia, Cosmonaut (International Space Station commander, Mir, and Soyuz cosmonaut, a record holder for the most days in space by any human - 879 days)
- Captain Ian Cameron - United Kingdom, Director of the Mission Control Centre.

Padalka joined the mission crew in Kazakhstan and got off in Mauritius.

Reportedly at the post-landing event, Mikkelsen and Starowicz the FAI adjudicator also identified as the first women in history to complete the polar circumnavigation of the earth.

### THE MISSION ROUTE

The high speed pumping "pit stops" were strategically decided

in Nur-sultan (Kazakhstan), Mauritius and Punta Arenas (Chile).

The mission required to start and finish at the same point on the earth, cross directly over the north and south poles, pass over the equator twice at between 120 and 180 degrees of longitude apart (i.e. we have to go up and down opposite sides of the earth).

"Our route around the earth from the NASA Shuttle Landing Facility in Florida involves four sectors, and three refuel locations in Kazakhstan, Mauritius, and Chile. Another critical part of the record is optimising the refuel times to operate like 'Formula 1 Pit Stops'. Our teams have already flown to each location in advance to plan and oversee the whole refuel process to reduce time on the ground to the absolute minimum possible. We will attempt to refuel stops of less than 45 minutes each touchdown to takeoff, which requires "no delay" arrivals and departures ahead of any other aircraft using the airport at the time," Captain Hamish Harding, Chairman of Action Aviation and Mission Director had said in his statement before the mission began.

Harding's statement also highlighted that the average speed over the course is calculated based on the Great Circle distance of our route which is 21,691 nautical miles (40,172 km). "However, real flight planned routes are never quite as direct as Great Circles and ours is currently 22,328 nautical miles (41,351 km). So, an important part of any speed record attempt is negotiating even more direct routings with Air Traffic Control as we proceed," he said.

### THE AIRCRAFT OF THE MISSION

Capable of reaching Mach 0.925 and sustaining a comfortable Mach 0.90, the aircraft of the mission, Gulfstream G650ER is claimed to be the fastest ultra-long-range business jet in the world currently. It is powered by two Rolls-Royce BR725 A1-12 Turbofans that generate 16,900 lbs of thrust with the extended-range variant being capable of flying 7,500 nautical miles (13,900 km) at up to 51,000 feet altitude.

The Qatar Executive G650ER aircraft which can fly non-stop from the Middle East to North America, or from destinations in Asia to Africa, has demonstrated new standards for business aviation with this successful mission. Airlines and business corporations should certainly see this as an opportunity to cover such long distances at the fastest speed if someone can manage to sit inside the aircraft for this long duration.

### REDUCING THE CARBON FOOTPRINT

One More Orbit has been exemplary in ways more than one. It has also successfully portrayed how airlines and corporations who own, lease or charter business jets can reduce carbon footprints without compromising on the provided services and products. The mission was sponsored by Carbon Underground to encourage emerging ways in which humans can combat carbon-driven climate change. The organisation promotes several carbon-reduction programmes. While this mission did not particularly entail any specific technology for reduction, the team reportedly calculated the amount of fuel their flight would burn and the carbon that would be created, and the amount of Earth's topsoil that would be required to counter that carbon impact. A contribution was then made by the mission team to the organisation to treat that amount of topsoil.

The crew had also established radio contacts and conducted video calls during the journey. The crew was in touch with the people on the ground with a live stream powered by inflight connectivity provider Satcom Direct, documenting the 25,000-mile (40,000 km) journey. A documentary about the mission is planned to be shared with the audience worldwide soon. **SP**



## INDIA INDUCTS AN AMERICAN LEGEND, AH-64E APACHE

**INDIA ON SEPTEMBER 3 TOOK A SIGNIFICANT STEP TO** modernise its firepower in support of military operations on the ground by inducting the first lot of eight US-made AH-64E Apache helicopter gunships into the Indian Air Force (IAF).

Equipped with Hellfire ground-attack missiles, the Apache increases India's strike options along disputed boundaries and will provide close-in airborne firepower support to advancing Army formations. Famed as a "tank in the air" and capable of operating at Himalayan heights, it is also the gunship India sorely missed having during the 1999 Kargil War.

Reputed to be the most lethal attack helicopters in the world, the first of the IAF Apaches were inducted into the 125 'Gladiators' Helicopter Unit at the Pathankot airbase in Punjab in the presence of the Chief of Air Staff, Air Chief Marshal B.S. Dhanoa, and the Air Officer Commanding-in-Chief of the Western Air Command, Air Marshal Raghunath Nambiar.

"Apache attack helicopters are being purchased to replace the (Soviet origin) Mi-35 fleet. Alongside the capability to shoot fire and forget anti tank guided missiles, air to air missiles, rockets and other ammunitions, it also has modern Electronic Warfare capabilities to provide versatility to helicopter in a network centric aerial warfare," said Air Chief Marshal Dhanoa at the induction ceremony, attesting that this formidable war machine would enhance the operational capabilities of the IAF.

"This procurement will enhance the capability of IAF in providing integrated combat aviation cover to the army strike corps. These tandem seating helicopters are day/night, all weather capable and have high agility and survivability against battle damage. These are easily maintainable even in field conditions and are capable of prolonged operations in tropical and desert regions," the IAF stated in a press release.

Earlier this year, on March 25, the IAF inducted another

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The gunship India missed having in the Kargil War, the first lot of Apache attack helicopters to operate from Pathankot airbase

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iconic American helicopter, the Chinook, in a significant upgrade of its rotary transport capability. Contracts for 22 Apaches and 15 Chinooks were signed by the Narendra Modi Government in September 2015 for an estimated \$3 billion. These contracts give India options to place follow-on orders for 11 more Apaches and seven more Chinooks. Both these helicopters are very distinctive symbols of growing India-US military cooperation.

The IAF will operate a fleet of 22 Apaches by 2020. The Ministry of Defence is processing the acquisition of six more of these gunships for the Indian Army, which will gradually take over the attack helicopter role from the IAF. India is the 16th country to operate the Apache.

The helicopter's is equipped with formidable weaponry including air-to-ground Hellfire missiles, air-to-air Stinger missiles and 70mm Hydra rockets. Apaches are also armed with a 30mm chain gun with 1200 rounds as part of area weapon subsystem. A fire control radar gives it 360 degree coverage and a nose mounted sensor suite enables very accurate targeting. It has night fighting capability and night vision systems.

The IAF's first Apache Commanding Officer is Group Captain Mannarath Shylu, a gunship veteran who was awarded a Vayu Sena Medal in 2011 for safely landing a Mi-35 in distress.

The Apache induction is also an important milestone for Boeing's Defence supplies to India. "Boeing is committed to supporting the modernisation requirements of the Indian armed forces and maintaining them to be mission-ready," said Salil Gupte, President, Boeing India. "We are confident that the Apaches will be an indispensable asset to the IAF. We will continue our efforts to deliver advanced capabilities to India's defence forces," he added. SP

—By Vishal Thapar

# WHO

## WILL BENEFIT?



### ARMED FORCES, CAPF & POLICE

REGIONAL SECURITY ENVIRONMENT  
DEFENCE BUSINESS  
MILITARY TECHNOLOGIES OF THE FUTURE  
ARMED FORCES MODERNISATION PLANS  
DEFENCE BUDGET ANALYSIS  
MAJOR DEFENCE R&D AND PRODUCTION PROGRAMMES IN INDIA

### POLICY & DECISION MAKERS

GEOPOLITICAL ENVIRONMENT  
DEFENCE ECONOMICS  
FUTURISTIC TECHNOLOGIES  
MODERNISATION PLANS  
ANALYSIS OF BUDGET  
INDIA'S MAJOR RESEARCH & DEVELOPMENT AND PRODUCTION PROGRAMMES

### DEFENCE & HOMELAND SECURITY INDUSTRY

- BUSINESS OPPORTUNITIES & TECHNOLOGY TRENDS
- MINISTRY OF DEFENCE ORGANISATION STRUCTURES & CONTACT DIRECTORY OF MAJOR BUYER COUNTRIES INCLUDING INDIA
- WHO'S WHO, GDP, MILITARY EXPENDITURE, MILITARY EQUIPMENT LISTING OF ABOUT 45 COUNTRIES
- PROCUREMENT POLICIES
- ANALYSIS OF BUDGET
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ASIA-PACIFIC SECURITY ENVIRONMENT  
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DEFENCE R&D AND MAJOR PRODUCTION PROGRAMMES IN INDIA

### ASPIRANTS FOR ARMED FORCES & CENTRAL SERVICES

UNDERSTANDING GEOPOLITICS & STRATEGY  
ELEMENTS OF MILITARY POWER  
CURRENT AFFAIRS  
UNDERSTANDING OF BUDGETS  
INTERNATIONAL RELATIONS  
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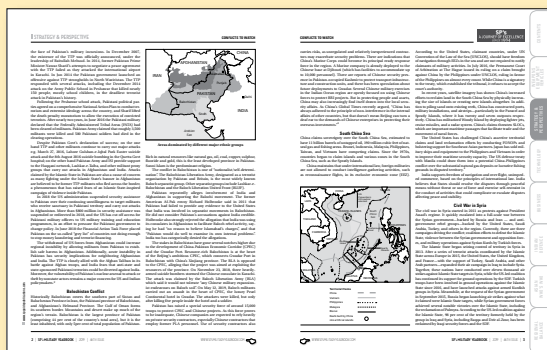
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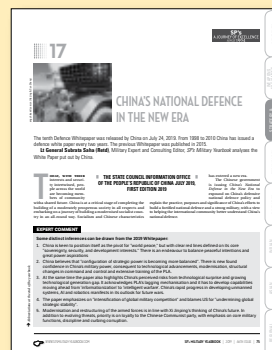


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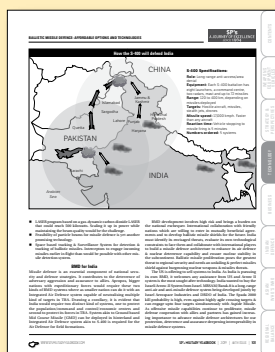
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The ten most important global conflicts to watch particularly from the point of view of India and this region.



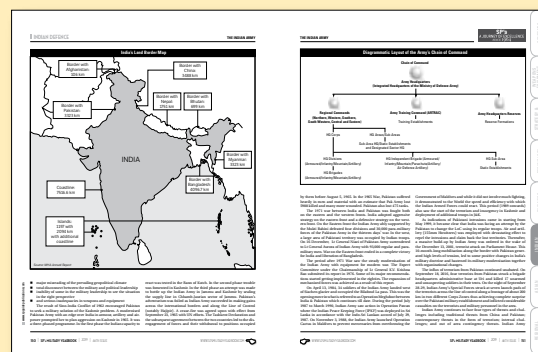
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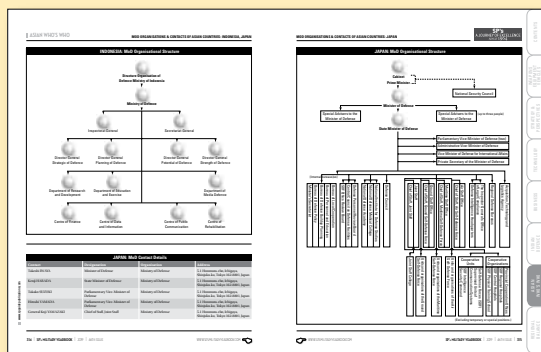
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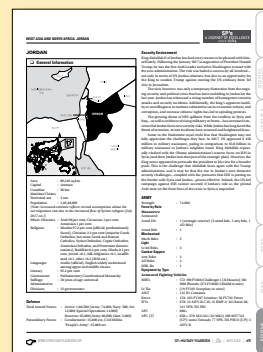
## INDIAN DEFENCE

Everything there is to know about Indian Armed Forces, Ministry of Defence, Defence Industry, Defence R&D and Central Armed Police Forces including Who's who, organisation structures, profiles and contact details.



## ASIAN WHO'S WHO

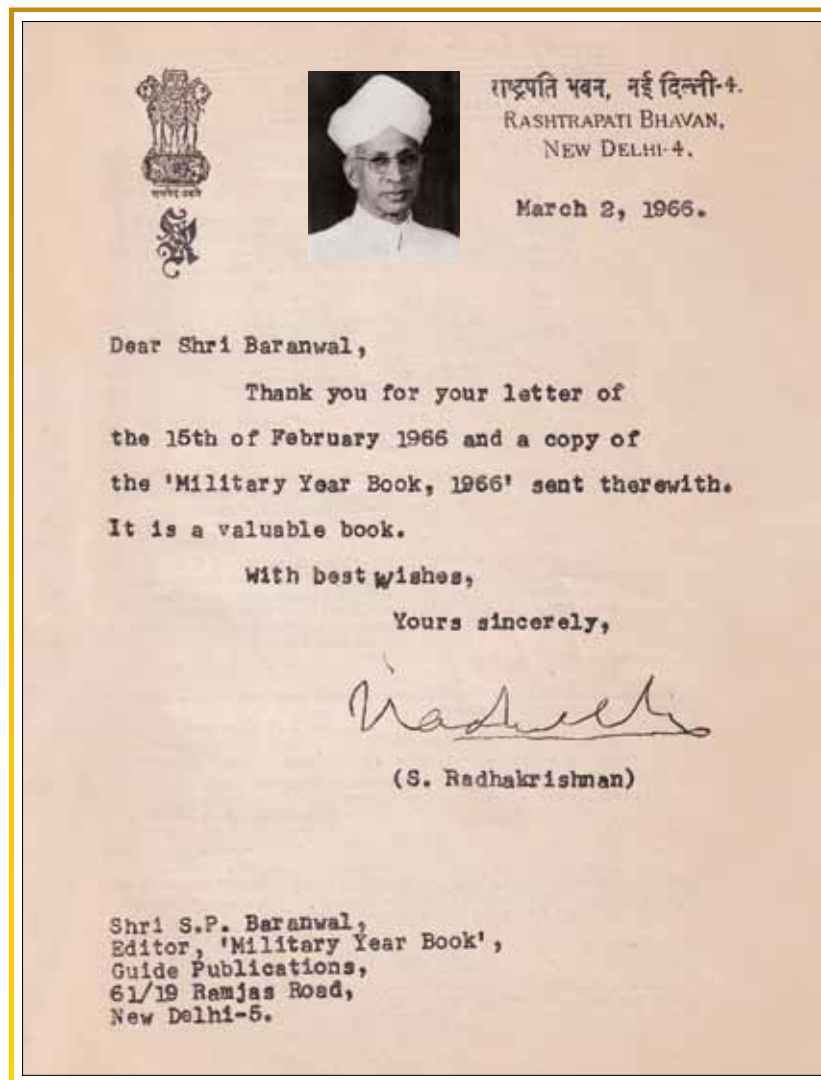
Who's who in 44 countries in Asia and Pacific along with the MoD organisation structures and contacts of 13 largest buyers of defence equipment in the region.



## REGIONAL BALANCE

GDP, military expenditure, security environment and listing of current military hardware of 45 countries in Asia and Pacific.

A Set of Kind Words from Dr S. Radhakrishnan, 2nd President of India,  
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# FRANCE STRONGLY PITCHES 2ND LOT OF 36 RAFALE FIGHTERS, SEEKS MOVEMENT ON STALLED AIRCRAFT PROGRAMMES

Strategic Dialogue between NSAs in New Delhi, a quick follow-up to Summit talks between Modi and Macron in Paris

## A STRATEGIC DIALOGUE BETWEEN THE INDIAN AND FRENCH

National Security Advisers in New Delhi on August 29, sought to take forward quickly the proposals put on the table to scale up Defence and Strategic sector cooperation between the two sides.

The meeting in New Delhi between India's National Security Adviser Ajit Doval and his visiting French counterpart Emmanuel Bonne took place exactly a week after the Summit meeting between Prime Minister Narendra Modi and French President Emmanuel Macron in Paris.

While there was no official statement on the Strategic Dialogue on August 29, sources suggested that the purpose was to give quick momentum to implementation of the Summit outcomes and proposals, with particular focus on defence, nuclear energy, space, cyber security, counter-terrorism and Indo-Pacific partnership.

A widely reported proposal relates to the French offer for a second batch of 36 Rafale fighters at an estimated cost of about 6 billion Euros. The first contract for 36 flyaway, Made in France Rafales in 2016 was signed for 7.8 billion Euros and generated a lot of political controversy in India. The second batch is on offer cheaper mainly because the cost of India Specific Enhancements and creation of infrastructure in India will not have to be incurred again.

The Indian Air Force (IAF), which is at least 10 squadrons short of the authorised fighter strength of 42 squadrons, and faces the prospect of further depletion of its ageing fleet, seeks quick replenishment, even if in part, particularly in the context of heightened military challenges.

Bonne, the Foreign Policy Advisor to President Macron, also reportedly sought renewed momentum to several stalled or ongoing procurements involving the Airbus C295 transport aircraft for the IAF – and possibly the Indian Coast Guard (ICG) and Navy too – the A330 for the IAF's Multi-Role Tanker Transport (MRTT) and AWACS requirements, the AS565 MBe Panther and H145 for the Naval Utility Helicopter programme and the H225M for the ICG.

Bonne also called on Prime Minister Modi during his short visit to New Delhi. The French agenda also includes the building of what will be the world's largest nuclear power plant at Jaitapur in Rajasthan, and, as first reported by *SP's Naval Forces*, the offer of cooperation in the Indian programme to build six

nuclear powered attack submarines (SSN).

The joint statement released after the Summit meeting on August 22 emphasised reaffirmation of the "commitment to further strengthen cooperation in defence industry field and extended their support to existing and upcoming partnerships between the defence companies of the two countries in the spirit of 'Make in India' and for the mutual benefit of both countries."

"Both sides noted with satisfaction that Indian MSMEs are increasingly becoming part of global supply chains of French Defence and Aerospace OEMs and reaffirmed to give further impetus to this trend. They welcomed the ongoing collaboration between aerospace and defence industrial associations of both countries, SIDM for India and GIFAS for France," the statement added.

The two leaders had also expressed satisfaction on the implementation of the 2016 Rafale contract, ahead of the first lot scheduled of the French fighters slated to be handed over to the IAF on schedule on September 19.

Another French priority is to project itself as a big player in the Indo-Pacific, with India as its key partner. It has also announced the appointment of a liaison officer at the Indian Navy's Information Fusion Centre – Indian Ocean Region (IFC-IOR) at Gurugram.

The French proposal reportedly includes 12 satellites for monitoring the Indian Ocean region.

The agenda for space cooperation includes the training of medical support personnel for Indian 'Gagannauts' for the manned space mission in 2022.

"The leaders welcomed signing of an Implementing Arrangement for establishment of a framework for the realisation of joint maritime domain awareness mission. They also hailed the launch of a Space Climate Observatory that further enhances Indo-French cooperation on combating climate change, besides TRISHNA joint mission and accommodating Argos in Oceansat 3. In an increasingly threatened environment, they have also resolved to act together at the international level to promote norms and best practices necessary for guaranteeing the safety of space missions," the Summit joint statement added. **SP**

—By Vishal Thapar



THE ADVISER TO THE PRESIDENT OF FRANCE, EMMANUEL BONNE WITH PRIME MINISTER NARENDRA MODI, IN NEW DELHI IN AUGUST 2019

# PANTSIR-S1 ADMGS: A PERFECT OPTION FOR INDIAN AIR DEFENSE



**THE PANTSIR-S1 AIR DEFENSE MISSILE AND GUN SYSTEM (ADMGS)** is a short range last stand protection against airborne threats with versatility of effect on all types of targets reaching the last defensive line, cruise missiles and high-precision weapons (HPW) in particular.

Pantsir-S1 fully satisfies all requirements for fighting modern air threats thanks to the specific features of its design:

- combined missile and gun armament that allows to create an entire engagement zone of up to 20 km in range and up to 15 km in altitude;
- jam-proof multimode and multispectral radar-optical control system operating in decimetric, millimetric and infrared wavebands;
- automatic operation;
- capability to fire on the move and from short stops;
- short reaction time of 4-6 sec due to automatic tracking of up to 20 targets by the search radar and high-precision target designation providing for quick fine search and target lock-on by the multifunction tracking radar and optronic system;
- self-contained combat operation and coordination of actions within a battery;

- simultaneous firing against four targets within a sector of  $\pm 45^\circ$  in azimuth and elevation.

Constant combat readiness of the Pantsir-S1 system is ensured by built-in test equipment in each combat and maintenance vehicle.

The Pantsir-S1 employs a modular design to allow various chassis (wheeled, tracked), stationary and sea-based installation for protecting huge range of targets of vital importance, both military, state and social. Such a design ensures easy integration into Customer's existing maintenance, training and logistics systems with minimum cost.

Moreover, the modular design ensures upgrade options to meet any future requirements in a cost-efficient way.

Pantsir-S1 ADMGS has been successfully tested in various climate conditions all the year round, day and night. Over 500 SAM launches were performed. The system is in serial production for the Russian Armed Forces and a number of international customers. The system has been successfully tested in combat including anti-terrorist operations in Syria to prove all its characteristics. The unique performance of the Pantsir-S1 ADMGS makes it a perfect option to strengthen the Republic of India and its Armed Forces air defense capabilities. SP





**LEADING ALL THE WAY:** EMBRAER DELIVERED THE FIRST PRODUCTION KC-390 AIRLIFTER AND TANKER TO WING 2 OF THE BRAZILIAN AIR FORCE (FAB) DURING A SEPTEMBER 4 CEREMONY AT ANÁPOLIS AIR BASE, BRAZIL

# EMBRAER'S 50 YEARS OF WONDER, INNOVATION AND SUCCESS

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From turboprop to eVTOL, the five decades of Embraer's journey have been nothing short of a fascinating transformation

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*By* AYUSHEE CHAUDHARY

PHOTOGRAPHS: EMBRAER



**INNOVATION AT IT'S BEST:** EMBRAER'S TIGER LIVERIED E190-E2 AIRLINER AT THE SINGAPORE AIR SHOW 2019; (ABOVE) EMBRAER'S eVTOL CONCEPT.

**WHAT STARTED AS AN AIRCRAFT MANUFACTURER TO CATER** to the civil as well as military aviation needs of Brazil 50 years ago, is the third-largest aircraft manufacturer in the world today.

Found in 1969 on the back of a single turboprop aircraft, the EMB 110, Embraer painted a significant picture for Brazil, putting it on the map of the global aviation industry. During the last five decades, Embraer has facilitated and developed solutions to improve human transportation.

#### HOW IT ALL BEGAN

In August 1969, the government of Brazil took a decision to invest in the aviation manufacturing industry and founded a company under the name of Empresa Brasileira de Aeronáutica (Embraer). The company was required to develop civilian projects as well as work on military contracts.

The 15-21 seater Embraer EMB 110 Bandeirante was Embraer's first aircraft. EMB 110 could be used by the government or even commercial businesses to serve small settlements around Brazil, suiting the regional passenger market as well as the military transportation. The manufacturer remained domestic until 1975 when its first internationally acknowledged aircraft, the Embraer EMB 120 Brasília was released.

Created by the Brazilian Government as state-owned, Empresa Brasileira de Aeronáutica S.A., Embraer was initially conceived to transform into engineering and industrial capacity, the science and technology developed by Brazilian Centro Técnico de Aeronáutica (CTA) as well as the Instituto Tecnológico de Aeronáutica (ITA). In 1994, Embraer was privatised and became the biggest exporter of high technology products of Southern Hemisphere and the third-largest manufacturer of commercial aircraft in the world.

#### EMBRAER'S EXTENSION

The company continued its successive trail in Europe when it slid into the jet range with its Embraer Regional Jet (ERJ) family. Having 30-50 seats, ERJ130/5 and ERJ140/5 aircraft gained popularity with regional airlines and witnessed over 1,200 ERJs being built. With ERJ145, showcased in 1989, Embraer made way into the regional airliner market as well. Making use of the same stretched fuselage of the EMB 120, the ERJ145 could accommodate 50 passengers and fly up to a range of 2,000 nmi depending on the variant. However, before it took its first flight in 1995 and became one of the major milestone of the company, the ERJ145 flew faced several hindrances since 1989 due to the dangling Brazilian economy.

Under the veil of success gifted by the ERJs, in 2002 Embraer decided to get enlisted in the larger aircraft market and introduced its freshly designed E-Jet family and welcomed global approval again. Offering economic, fast and reliable flights on short routes, the E170/175 and E190/195 became ideal for airlines operating inter-cities in Europe and North America.

Unveiled in 2013, the E-jets were then refurbished into the E-Jet E2 range. E2 treatment was given to the E175, E190 and E195 consisting of uprated engines, improved wing design, new avionics and an updated cabin. This marked yet another successful tryst with regional airlines. With a capacity of around 80 passengers, the E175-E2 was the smallest one while the E190-E2 had around 96 seat capacity. The 120 seater E195-E2 is, however, the largest aircraft built by Embraer. While the E190-E2 entered airline service in 2018, the E195-E2 received certification in early 2019 and is expected to have its first delivery later this year or early next year. The E175-E2's first flight is scheduled before the end of this year and deliveries are to begin later next year or early 2021.

Today Embraer has made its mark not only in the civil aircraft range but also in the business aviation industry with its impressive fleet of Business Jets that include the Phenom and Legacy series.

A range of military and agricultural aircraft that includes the well-known Tucano is also produced by Embraer.

#### ADVANCING TOWARDS THE FUTURE

**As the company's website states:** "The future will lead us into extraordinary challenges, but we're dedicated to develop new technologies that will help us overcome these barriers. Whether in the sky, on land, at sea, or in the cities, Embraer is ready to propose disruptive solutions and build what's next. With Embraer, the future is closer than you ever imagined."

- Recently, Embraer has disclosed its first fully electric aircraft. Currently, under development, it is a demonstrator project comprising of 100 per cent electric propulsion technology. For the elementary evaluation of the electrification technology, the small, single-engine aircraft based on the EMB-203 Ipanema agricultural aircraft shall be installed with the technology to be tested. Ipanema, the agricultural aircraft provided the basis for the electric prototype. The

## 50 YEARS OF EMBRAER: SOME MILESTONES

**1969**

Empresa Brasileira de Aeronáutica (Embraer) founded in 1969. Embraer EMB 110 Bandeirante is Embraer's first aircraft

**1975**

First internationally acknowledged aircraft, the Embraer EMB 120 Brasília was released

**1994**

Embraer is privatized and become the third-largest manufacturer of commercial aircraft in the world.

**1995**

ERJ145 flew for the first time and becomes one of the major milestone of the company

**2002**

Embraer decides to get enlisted in the larger aircraft market and introduces its freshly designed E-Jet family

**2020**

E175-E2's first flight is scheduled before the end of this year and deliveries to begin later next year or early 2021

**2019**

Strategic JV with Boeing in the commercial aviation area and also with regard to the multi-mission aircraft KC-390

**2019**

E195-E2 receives certification. Expected to have its first delivery later this year or early next year.

**2018**

E190-E2 enters airline service in 2018

**2013**

E-jets gets refurbished into the E-Jet E2 range. E2 treatment is given to the E175, E190 and E195 with new engines, etc

first flight of this aircraft is scheduled in 2020, until then the demonstrator aircraft will continue to go through tests.

- EmbraerX rolled out its new goals for the development of eVTOLs, their air traffic regulations and the creation of a fleet agnostic aviation services network at the Uber Elevate Summit 2019. The air taxi with an eight-rotor system, aims to optimise urban environment and focus on high reliability, low operating costs, and low noise footprint.

**THE EMBRAER-BOEING PARTNERSHIP**

In the same year that Embraer celebrates its 50th anniversary, the company also undergoes major changes. One of them is its strategic joint venture with Boeing in the commercial aviation area and also with regard to the multi-mission aircraft KC-390.

Last year, a major announcement came when two of the largest aircraft manufacturers, Boeing and Embraer announced a strategic partnership that positions both companies to accelerate growth in global aerospace markets. The proposal had highlighted the formation of a joint venture comprising the commercial aircraft and services business of Embraer that would strategically align with Boeing's commercial development, production, marketing and lifecycle services operations. Under the terms of the agreement, Boeing will hold an 80 per cent ownership stake in the joint venture and Embraer will own the remaining 20 per cent stake.

In addition, both companies will create another joint venture to promote and develop new markets and applications for defence products and services, especially the KC-390 multi-mission aircraft, based on jointly-identified opportunities.

The proposed partnership has received shareholders' approval, ratification by the board of directors and the authorisation by the Government of Brazil this year.

**50 YEARS' CELEBRATION**

Bringing together employees, authorities and commercial partners at the company's headquarters, in São José dos Campos, Brazil, Embraer celebrated its 50-year anniversary on August 19, 2019.

"Embraer resulted from the determination of visionaries who wanted to transform the impossible into reality – and they did it. That's what we want to show with these actions at this historic moment for the company. We grew up with this spirit, we've reached 50 and that is how we will continue over the next decades," stated Francisco Gomes Neto, President, and CEO of Embraer in a press release.

Several activities were planned and prepared through the last year to remember the five decades of Embraer's journey:

- To share that journey in details, Embraer had also been conducting a series of global promotional actions in Brazil and abroad including participation in events and airshows in the Americas, Europe, Middle East, and Asia, demonstration flights, a historical exposition of classic and new aircraft and the launch of a commemorative edition book.
- An air show of the Embraer fleet also took place that enthralled thousands of people who had gathered at the venue to be a part of the festivities.
- A digital campaign, "Journey of Wonder", narrated the 50 years of the company that led it to become the global leader of manufacturing commercial jets up to 150 passengers and a prestigious player in such a competitive market as business aviation.
- As part of the celebrations, Embraer also promoted the global media campaign "Challenge-driven, dream-driven". With presence in programmatic media and social media, advertisement in newspaper and magazines, in addition to advertising movie, the campaign show the company's over-





**VERSATILE AND EFFICIENT:** IN 2015, THE IPANEMA 203 WAS LAUNCHED WHICH USES RENEWABLE ENERGY (ETHANOL). THE AIRCRAFT IS MORE AGILE AND EFFICIENT, WHICH ENSURES GREATER PRODUCTIVITY.

coming stories and its achievements, showing the greater contributions of both its human and technological capital, to the global aerospace industry.

- To inspire people to fly high, the exhibition “On the wings of imagination” was also presented by Embraer in a city park in São Paulo, Brazil. In an immersive and fun place, some milestones and aircraft that marked the company’s history were introduced, in addition to an ERJ 145 model, banners and seesaws.
- Through information and images of the first aircraft and factories built in Brazil, Embraer’s website has also highlighted the history of the Brazilian aeronautics industry.
- The social media channels of the company showcased daily content and testimonials that highlight the motivation, the dreams, the challenges and other curiosities related to our people and to our products.

The company designs, develops, manufactures and markets aircraft and systems, providing Services & Support to customers’ after-sales celebrated its 50th anniversary with successful operations in various aviation sectors:

**Commercial Aviation.** The Company has 100 customers from all over the world operating the ERJ and E-Jet families of aircraft. The E170, E175, E190, and E195 set the standard in their category with their advanced engineering, a high degree of efficiency, spacious, ergonomic cabins with two-by-two seating, and attractive operating economics. For the E-Jets programme alone, Embraer has logged more than 1,800 orders and 1,500 deliveries to some 70 airlines in 50 countries, and same and more is expected from the E-Jets E2 range.

**Defence & Security.** A complete line of integrated solutions such as C4I (Command, Control, Communication, Computers

and Intelligence Center) applications, leading-edge technologies for air traffic control, communication systems, monitoring and surveillance, as well as military and government transportation aircraft is offered by Embraer in this category.

The KC-390 is a tactical transport aircraft designed to set new standards in its category while presenting the lowest life-cycle cost with an international market potential. While the A-29 Super Tucano, light-attack aircraft and advanced training is also world-renowned and selected by 15 Air Forces, including the United States Air Force (USAF).

**Executive Aviation.** Embraer is one of the world’s leading executive jet manufacturers, having entered the business aviation market in 2000 with the Legacy jet, which led to the launch of Embraer Executive Jets in 2005.

Its portfolio, among the broadest in the market, consists of the entry-level Phenom 100EV and the light Phenom 300E jet, the medium cabin Legacy 450 and Legacy 500, the midsize Praetor 500 and super-midsize Praetor 600, the large Legacy 650E, and the ultra-large Lineage 1000E.

**Agricultural Aviation.** The crop duster Ipanema is one of the first aircraft launched by Embraer and manufactured uninterruptedly for close to 50 years. In 2015, a new version of the aircraft, the Ipanema 203 was launched. Moved by renewable energy (ethanol), the aircraft is more agile and efficient, which ensures greater productivity. It can be used to spread seeds, fight vectors and larvae, in primary firefighting and river settlement.

**EmbraerX.** Keeping up with its innovation-centric approach, a wholly-owned Embraer subsidiary, EmbraerX exists to build disruptive businesses, considering that transportation will probably be disrupted by the exponential growth of new technologies as well as the development of new business models. **SP**

# ENGINE LEASING

Aircraft spare engine leasing is separate from aircraft leasing because engines require more intensive technical management

*By* GROUP CAPTAIN A.K. SACHDEV (RETD)



SHANNON ENGINE SUPPORT LIMITED SPECIALISES IN PROVIDING SPARE ENGINE LEASE SOLUTIONS TO CFM56 AND LEAP OPERATORS AROUND THE GLOBE

**IN GENERAL, THE AIRLINE INDUSTRY IS CAPITAL INTENSIVE** and the aircraft used by it are high cost and long life assets. Moreover, how these aircraft come to be flying with a particular airline is not always the result of a simple purchase from the aircraft Original Equipment Manufacturer (OEM). The most common *modus operandi* is a sale and leaseback wherein a tripartite agreement between the airline that originally booked an aircraft with the OEM lets a leasing company buy it from the OEM and then the airline leases it from the leasing company. Payments to OEMs include options (amounts paid in advance to book an aircraft purchase), purchase rights, deposits and progress payments. While aircraft leases have been in vogue ever since airlines started sprouting up, engine leasing market started emerging only around three decades ago. At first glance, leasing of an engine differentiated from purchase or lease of an aircraft of which it is a part, appears befuddling, but there are financial reasons for this to happen which have evolved from experience over decades of commercial operations.

## ENGINE LEASING

It is customary for a car or a load carrying vehicle to be designed to carry a single (the same) engine for its entire life; in contrast, an aircraft engine is a replaceable part of the aircraft which gets replaced several times during an airframe's useful life, depending on aircraft type, utilisation rate, company policies, regulatory mandates and occasionally due to accidents/incidents. As

aircraft down time is expensive in terms of lost revenue, airlines generally maintain a number of spare engines to ensure aircraft are not grounded when engines are removed for normal maintenance or as a result of failure. Prior to development of the aircraft spare engine leasing business, airlines had to manage engine removals via spare engine ownership or expensive emergency engine leasing. Aero engine leasing is not as old as aircraft leasing and not long ago operators owned their engines including the spare ones they needed. However, as engines became more powerful and more technically advanced, their costs also skyrocketed; in addition to initial costs, their maintenance costs also increased considerably. Engine leasing became attractive for the same reasons as aircraft leasing in a capital intensive, cost conscious resource milieu. When an aircraft is acquired by an operator, it would normally establish an engine life cycle management plan so as to maximise on wing time and reduce workshop time to the minimum. This plan aims at finding a middle ground between airworthiness perspectives and cost saving considerations over engine life cycle.

Aircraft spare engine leasing is separate from aircraft leasing because engines require more intensive technical management. Since engine overhauls are one of the largest airline operating cost segments, each overhaul must be closely managed. Engine lessors work with airline customers to optimise the cost and ready availability of spare engines at short notice. Pratt & Whitney (P&W), a leading engine OEM has its engines mounted

on more than 130 different aircraft types including regional airliners, business jets, general aviation aircraft and helicopters. To support this vast market and related Maintenance Repair & Overhaul (MRO) activities, P&W claims that it offers the largest engine rental and exchange pool of any engine OEM in the form of more than 850 engines worldwide to support its MRO activities. The other leading engine OEM is CFM International, a 50/50 joint company formed in 1974 by Snecma (Safran) in France and GE in the US. Shannon Engine Support Limited (SES), a wholly-owned subsidiary of CFM International, specialises in providing spare engine lease solutions to CFM56 and LEAP operators around the globe. Headquartered in Shannon, Ireland, with marketing offices in Beijing and Budapest, SES has a portfolio of over 200 CFM56 and LEAP spare engines, including CFM56-5B, CFM56-7B, LEAP-1A and LEAP-1B engines. SES' 13 strategic pool locations give SES both the capacity and the reach to support airlines operating CFM engines worldwide. The Rolls-Royce & Partners Finance companies (collectively, the "RRPF Affiliates") are a collection of 50 per cent owned domestic and foreign joint ventures with Rolls-Royce, another leading manufacturer of commercial aircraft jet engines. The RRPF affiliates are primarily engaged in two business activities: lease financing of aircraft spare engines to a diverse group of commercial aircraft operators worldwide and sale-leaseback financing of aircraft spare engines to Rolls-Royce for use in their engine maintenance programmes. GE Engine Leasing Holdings Incorporated is another big name in engine leasing business. Besides these, there are dozens of companies like Engine Lease Finance and Willis Lease which have spare engines to lease out for lease rentals include long term lease on the one end and short term ones, even on a daily basis, on the other. Perhaps the most dynamic part of the engine leasing market is the short term leasing segment in the newer narrow body engine types.

#### INDIAN SCENARIO

Regrettably, India produces no commercial aircraft and its entire airline industry is reliant on import of foreign-built aircraft under lease or ownership. The Indian scene is dominated by lease in contrast to ownership. Aviation finance and leasing are not covered under any specific legislated Act in India, but are governed by Indian contract laws, Indian company laws and Indian foreign exchange regulations. Also, the (Indian) Aircraft Act, 1934, read with the (Indian) Aircraft Rules, 1937 and the Civil Aviation Requirements (CARs) promulgated by the Directorate General of Civil Aviation (DGCA) from time to time, governs important aspects of aircraft leasing in India. In this context, it is pertinent to point out that International Civil Aviation Organisation (ICAO) has not provisioned for a formal definition of the term 'lease' in relation to aircraft. This is basically because national laws governing lease contracts vary and the negotiating process results in individual variations in the terms and conditions of aircraft leases since these are usually tailor-made to specific situations. However, ICAO's Manual on the Regulation of International Air transport (Doc 9626), describes 'aircraft leasing' as the rental rather than purchase of aircraft by an aircraft operator from another operator or a non-air operator entity. In essence, an aircraft lease is a contractual arrangement in which an aircraft operator (the lessee) rents an

aircraft from either another operator or a financial institution (the lessor). India has ratified the 1997 Article 83bis of the Convention on International Civil Aviation 1944 which was the first substantial amendment of the Convention and came about in response to industry growth and leasing trends. Under Article 83 bis, a bilateral agreement can be signed between the aviation authorities of two contracting states and that agreement transfers and delegates the responsibility for the regulation and safety oversight of an aircraft in accordance with the requirements of the state of registration from that state to the air transport authorities in the airline's home state. DGCA meticulously maintains a register of aircraft with details of aircraft type, year of manufacture, full name and address of the owner or lessor and of the operator or lessee. The notable point is that there is no engine-specific register in India to record separate registration title of an engine on an aircraft, whether maintained by DGCA or any other registry. The certificate of registration for the aircraft does not include details of the engine(s) mounted on it.

#### CONCLUDING REMARKS

Aircraft engine leasing is a highly effective and economical alternative even for large operators who own the majority of their engines as they too need leased engines in times of high unscheduled engine removals (UERs), Life Limited Parts (LLP) shop visits etc. The flexibility to plan removals, UERs, warranty issues etc, relies upon the use of leased assets. In reality, the cost of ownership versus leasing can make a huge financial impact on the operators. Although engines are increasingly reliable, they are complex and when they are removed from aircraft for maintenance, repairs can take a long time to complete. Also, some events such as bird strike cannot be predicted. Spare engines are a small segment, around two percent, of the total aviation finance market.

Digital technologies and Artificial Intelligence are helping airlines reduce spare engine requirements by accurately predicting engine removals, but spare engines are vital as all engine removals cannot be predicted. Although no figure can be put on the number of spare engines required by an airline, the generally accepted ratio is one for every ten in use. However, local conditions, airline financial health considerations and operational models may dictate variations from this thumb rule. There is tough competition amongst the engine leasing market players to provide more and more attractive and innovative options to lessees. Cost focused airlines are increasingly able to reduce the required number of dedicated spare engines and where possible, rely on the spot market, pooling or engine availability services. These non-dedicated spare engine services can in theory, increase overall asset utilisation across the market and reduce costs for airlines. Another healthy trend is availability of "green time" engines; the term refers to older engines with limited life remaining that have been taken from aircraft that have been retired. These are offered into the market by a used parts company and very often they are held on the lessor's books for very low values and it is possible for these lessors to offer the engines into the spot market at attractive short-term rental and utilisation rates. In general, the trends for the engine leasing market appear to favour the airlines. SP

**It is pertinent to point out that International Civil Aviation Organisation has not provisioned for a formal definition of the term 'lease' in relation to aircraft**



# TECHNICALITIES OF BOEING 737 MAINTENANCE

Boeing was considering building an all-new airplane in 2011, but under intense pressure from its chief rival Airbus, Boeing decided to update the 737 instead

*By* AIR MARSHAL SUKHCHAIN SINGH (RETD)

**THE BOEING-737 IS A SHORT-TO-MEDIUM-RANGE, TWIN-JET,** narrow-body airliner produced by Boeing. It is Boeing's only narrow-body airliner in production, with the 737 Next Generation(-700, -800, and -900ER) and the re-engined and updated 737 MAX variants. Notable features are as under:

- **Flight Controls:** The Boeing-737's flight controls are intrinsically safe. In the event of total hydraulic failure or double engine failure, they automatically and seamlessly revert to control via servo tab. In this mode, the servo tabs aerodynamically control the elevators and ailerons. The servo tabs are in turn controlled by cables running to the control yoke. The pilot's muscle forces alone control the tabs. For the 737 Next Generation, a six-screen LCD glass cockpit with modern avionics, was implemented while retaining crew commonality with previous generation 737.
- **Winglets:** The 737 has four different winglet types: 737-200 Mini Winglet, 737 Classic/NG Blended Winglet, 737 Split Scimitar Winglet, and 737 MAX Advanced Technology Winglet. Blended winglets are in production on 737 NG and are available for retro-fit on 737 Classic models. These winglets are 2.4m tall and are installed at the wing tips. These help to reduce fuel burn by reducing vortex drag, engine wear and take-off noise.
- **MCAS:** Boeing was considering building an all-new airplane in 2011, but under intense pressure from its chief rival Airbus, Boeing decided to update the 737 instead. Boeing designed the Max, a single-aisle jet that seats 200 passengers and flies farther and more efficiently than previous models of the 737. To do that, it equipped the Max with larger engine, the new CFM LEAP-1B engine. This changed the plane's aerodynamics and rendered it more prone to stall in some aerodynamic conditions. To offset the risk of a stall, Boeing developed the Manoeuvring Characteristics Augmentation System (MCAS), which pushes the plane's

nose down under certain conditions to stabilise the aircraft. But MCAS relied on data from just one of the plane's two angle of attack sensors that are mounted on the plane's exterior to monitor its angle of attack.

## CRASH OF THE BOEING MAX 8

In October 2018, Lion Air Flight 610 crashed just minutes after take off from Jakarta, killing 189 people. In March 2019, another Boeing 737 Max of Ethiopian Airlines, crashed minutes after take off killing all 157 on board. The Max remains grounded after the second crash and Boeing is working on updates. Boeing CEO, Dennis Muilenburg recently reaffirmed his optimism over the 737 MAX's return to service in the fourth quarter of 2019. Muilenburg also gave assurance that the company planned to fix the 737 MAX software problems by September 2019. The initial investigation report suggests a fault in the aircraft's MCAS. In April 2019, the company had claimed that it had completed a software update for MCAS. However, during a simulator test, FAA pilots found that the updated system was taking a long time to respond in a situation where the plane's nose was pitched down. They

pointed out that the issue could affect a pilot's ability to react quickly, increasing the risk of crash. Therefore, Boeing is now looking for a complete solution so that the flying ban on 737 MAX planes doesn't drag on any further. The company is now changing the software architecture of the MCAS system itself. The change will allow the aircraft to take inputs from both of its flight-control computers instead of just one. For decades, Boeing's 737 series planes have been designed to receive data from only one flight-control computer. The FAA and Boeing have come under scrutiny for their training and certification procedures. Boeing will now include a revised Flight Manual and Crew Operations Manual. Moreover, a new Quick Reference Handbook, Airplane Maintenance Manual and a new Interactive Fault Isolation Manual will be included.



## MAINTENANCE INTRICACIES

The 737, like all airliners, undergoes periodic heavy maintenance and checks. Timelines of maintenance checks and nomenclature are as follows:

- **A Check** – every 500 flying hours and are known as a P1 Check
- **B Check** – every six months and incorporated into A or C Checks
- **C Check** – every 4,000 to 6,000 flying hours or every two to three years. Now called P8, P10 or P12 Checks
- **D Check** – every 24,000 to 40,000 flying hours or every nine to 12 years. Designated as P48 Checks.

## PHASE CHECKS

One of the advantages of the 737 NG over the 737 Classic is that Boeing allows for intermediate base C Checks before the D Check to reduce the time, work and expense required at the D Check. Operators that have a maintenance programme with a P48 Check, can have a base check interval of eight phases (hence the name P8), where one phase equals 500 flying hours and so have six Base Checks in the base maintenance cycle. These will be P8, P16, P24, P32, P40 and P48 Checks, often referred to as C1, C2, C3, C4, C5 and C6 Checks. The P8 Check will have an interval of 4,000 flying hours and up to 18 months. The maintenance cycle will, therefore, have an interval of 24,000 flying hours and up to nine years. A typical P48 Check or (D Check) can take 20,000 to 30,000 man-hours, two months to complete and cost several million dollars. Most operators will also use the opportunity of the D Check to incorporate other tasks such as incorporating EOs, ADs, SBs, changing or refurbishing the interior and making any desired modifications to the aircraft.

Several innovations helped reduce MRO costs. NG's new wings have nearly one-third fewer parts than Classic wings. Its leading edge was also redesigned for easier maintenance. The main landing gear on NGs is simpler and the time required for brake changes was cut by 30 per cent. Access to many NG Line Replaceable Units (LRUs) was made easier and quick-disconnect line fittings were used wherever possible. In addition, better ground support equipment was provided, halving the time required for engine removal and installation. NG auxiliary power units were made easier to access and maintain, as were bays for electronics and other equipment. Boeing improved NGs' Built-In Test Equipment (BITE) user interfaces to reduce troubleshooting time and errors. Boeing NGs use digital cabin-pressure controls instead of analogue systems, reducing the number of mechanical parts. This redesign helped BITE more quickly identify problem LRUs or wiring defects, reducing troubleshooting time. BITE also cut this system's mean time between unscheduled removals by 75 per cent.

Another NG upgrade integrated stall management and yaw-damper computers in a single unit, improving reliability and reducing maintenance costs. On NG flight decks, Boeing enhanced systems, reliability, redundancy and BITE to increase mean time between failures by 62 per cent.

## MRO MARKET

The pace of MRO spending follows fleet size, with a slight lag. Car-

riers have spent nearly \$4.8 billion maintaining the 737-800 in 2018, and nearly \$7.8 billion in 2019. Again, more than 90 per cent of this is spent outside airframe-check hangars. C and D checks accounted for \$418 million till 2017, then climbed to \$541 million by 2019. Aviation Week Network predicts the maintenance market for all 737 types to reach \$21.7 billion. Of that total, 41 per cent is for component work, 27 per cent for engine maintenance, 22 per cent for line maintenance, five per cent for airframe work and five per cent for modifications. Most of that MRO demand is for the 737-800 which provided \$14.7 billion of maintenance value in 2018 and is expected to rise to \$16.6 billion by 2022.

## MAX GROUNDING: MAINTENANCE WOES

MAX operators all over the world realised that the problem that led to grounding of the 737 MAX was not going to be solved overnight. As such, most have sent their 737 MAXs to storage facilities, where possible, to hot and dry places to minimise degradation. However, the logistics of bringing lots of aircraft back into service all at once is not an easy task. According to the Boeing website, "Returning a parked airplane to service after a lengthy down time requires extensive restoration of its systems. While the

airworthiness of an in-service airplane is proven, the airworthiness of an airplane after extended downtime must be certified before it resumes operations. As a result, the process for returning an airplane to service after extended downtime for maintenance or parking must include attention to controlled, repeatable maintenance processes."

Returning one or two planes to service after being parked is not much of a challenge. However, for airlines such as Southwest, who had a large fleet of MAX in operation, finding enough hangar space, mechanics and spare parts, is a major task. As such, it could be several months from the recovery of the MAX before they can return to an operational state. Another effect, a few analysts have considered, involves maintenance planning. The longer the

grounding continues, the more scheduled maintenance events will become due, particularly those unrelated to the number of hours a particular airplane has flown. As a result, the airlines have to bear the costs, both due to the need for upkeep on grounded aircraft and to revisit overall maintenance plans.

Calendar-driven maintenance tasks cover items such as seals or parts subject to corrosion. Other tasks maintenance crews need to perform on grounded airplanes include running the APU, draining engine oil and replacing it with special conservation oil, placement of desiccant bags in the cabin and removal of certain avionics among several other preventive steps to protect the airplane from climatic effects.

Because the airplanes are not flying, calendar activities versus the activities based on flight hours and flight cycles, become out of sync. One objective when you undertake maintenance is to complete as many activities as possible to reduce the amount of time the aircraft is grounded for maintenance. Most airlines have an automated way of aggregating these tasks. So if one has a calendar task at 24 months, based on the expected utilisation, you know which flight-related tasks one has to undertake at the same time. But, because of no flying, that kind of automation for bundling of task is not factored in and becomes difficult for the airlines. **SP**

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flown



## BOEING B-52 STRATOFORTRESS— OLD IS GOLD!

The USAF relies on the B-52 because it has proved to be the most effective and economical heavy bomber option against nations with limited defensive capabilities

**IT SEEMS STRANGE THAT THE WORLD'S LARGEST AND MOST** powerful Air Force which flies only the most advanced aircraft, still operates a bomber that first flew in 1952. But the Boeing B-52 Stratofortress is no ordinary plane. It is a highly capable, long-range, heavy bomber that can operate at altitudes of up to 15km. Affectionately called the Big Ugly Fat Fella (BUFF) due to its rather ungainly appearance, it entered service with the United States Air Force (USAF) in February 1955. A total of 744 B-52s were built and the last batch of 102 aircraft of the final B-52H variant was delivered to the US Strategic Air Command (SAC) in October 1962.

The B-52 was originally intended only as an atomic-bomb delivery vehicle against the Soviet Union, but it has proved adaptable to most types of offensive air missions. It can deliver a range of conventional weapons anywhere in the world thanks to its precision navigation and inflight refuelling capability. For decades, it formed the backbone of the US strategic bomber force. It has served in practically every conflict that America has been involved in since the mid-1950s and is undoubtedly the longest-serving US military aircraft in history. Several replacements have been proposed and even attempted; but it has outlived them all.

The B-52 has a swept-wing configuration with eight engines paired in pods and suspended on four pylons beneath and forward of the wing's leading edge. It has a crew of five. Its maximum takeoff weight is 219,600 kg. Originally fitted with turbojet engines it was modified in May 1961 with cleaner burning and quieter Pratt & Whitney TF33-P-3 turbofans. These engines, each with a maximum thrust of 17,100lbf (76.06 kN), give it a speed of up to 1,040kmph (Mach 0.84). The aircraft is equipped with advanced targeting pods that enable improved long-range target detection, identification and continuous stabilised surveillance for offensive missions, including close air support of ground forces. It can carry approximately 31,500 kg of bombs, mines and missiles in different configurations. It can attack ground targets with a variety of standoff weapons including gravity bombs, cluster bombs, precision guided missiles (PGM), joint direct attack munitions (JDAM) or up to 20 Boeing AGM-86 air-launched cruise missiles (ALCM). It has an unrefuelled combat range of over 14,000 km.

On May 21, 1956, a B-52 dropped a single Mk-15 nuclear bomb over the Bikini Atoll – the first air-dropped thermonu-

clear weapon. Thereafter the B-52 became a critical element of America's defence policy of massive retaliation. According to this policy, the Soviet Union would be deterred from using its nuclear weapons by the threat of an all-out nuclear response by the US strategic bomber fleet. Accordingly, the SAC always kept one third of its fleet of B-52s on quick reaction alert, ready to takeoff towards pre-designated Soviet targets within 15 minutes. During times of increased tension, armed B-52s were kept continuously airborne in rotation, ready to execute their deadly missions. When the Soviet Union improved its anti-aircraft defences rendering high-level ingress unsafe, the B-52s were adapted as low-penetration bombers. Flying at a height of just 150 m above the surface of the Earth, they could evade enemy radar pickup and deliver weapons.

The aircraft played a major role in Vietnam, repeatedly pounding Hanoi and Haiphong as well as carpet-bombing the Viet Cong. However, this conflict took a terrible toll of the B-52 fleet. No less than 31 bombers were lost, including 17 shot down in combat operations. They were also extensively used in the First and Second Gulf Wars, as well as over Yugoslavia and Afghanistan. During Operation Desert Storm, B-52s flew more than 1,600 sorties. Their combat employment continues even now with bombing missions reported over Syria last year.

And that is not the end of the story. Indications are that the B-52 will probably reach a century as an active bomber. The USAF relies on it because it has proved to be the most effective and economical heavy bomber option against nations with limited defensive capabilities. A B-52 costs about \$70 million against \$3 billion for the Northrop Grumman B-2 Spirit. The original B-52 has been considerably upgraded and is planned for further upgrades, the most important of which will be the provision of new engines and avionics. According to official figures, as of June 2019, the active fleet of B-52s was 58 aircraft with 18 in reserve. The US bomber fleet in the mid-2050s is expected to number 100 Northrop Grumman B-21 Raider stealth aircraft currently under development and 20 B-2 Spirit planes together with 70+ Boeing B-52H Stratofortress bombers. Not bad for an aircraft that was initially planned to be withdrawn from service in 1975. SP

— JOSEPH NORONHA



## INDIAN AIR FORCE TO UPGRADE SU-30MKI

Air Chief Marshal B.S. Dhanoa, Chief of the Air Staff, Indian Air Force (IAF) stated that the IAF wants to upgrade its SU-30MKIs with the help of Russia to make the aircraft more lethal. The Su-30MKI will need new avionics and weapons, he said. Russia has already helped India upgrade MiG-21, MiG-27 and MiG-29 fighters. The Su-30MKI is a twin-engine, twin-seat, multi-role fighter that can be operated as an interceptor, bomber and trainer. The IAF fleet of Su-30MKIs currently consists of around 260 aircraft. As of December 2018, HAL has manufactured 202 Su-30MKI aircraft in India. The first 50 aircraft were built in Russia and delivered to India in fly-away condition. The IAF is expected to deploy 272 Su-30MKI aircraft by 2021 grouped into 14 squadrons.

## US FMS TO INDIA FOR C-17 WORTH \$670 M

The US has approved an FMS worth \$670 million to support India's C-17 Globemaster III military transport aircraft. The decision in this regard comes after a recent Indian request to buy equipment for C-17 follow-on support, to include spares and repair of parts, support equipment and personnel training and training equipment among others. The C-17 Globemaster III is a high-wing, four-engine, T-tailed military-transport aircraft that can carry large size equipment, vehicles, supplies and troops directly to small airfields in harsh terrain anywhere in the world by day or night.

## QUICK REACTION SURFACE-TO-AIR MISSILE TESTED SUCCESSFULLY

India has conducted a successful test-launch of its indigenous Quick Reaction Surface-to-Air Missile (QRASM). The missile is designed for canisterised storage aboard a transporter-erector-launcher vehicle. QRASM has a range of 30km and uses solid rocket propellant. The QRASM entered testing phase two years ago, with its first test taking place on June 04, 2017. A test in December 2017 failed.

## LIKELY SALE OF BRAHMOS TO THAILAND

Thailand wants to buy BrahMos cruise missiles and has been in talks with India for the purchase. The BrahMos missile system can be used in ground attack and shore defence modes. The BrahMos missile has a range of about 300km and weighs 2.5 tonnes. The missile was developed by India in collaboration with Russia and has a maximum speed of 3,450kmph. While Thailand expressed interest in the missiles some time back, discussions picked up pace after the visit of Royal

## SHOW CALENDAR

15-20 October

### SEOUL ADEX 2019

Seoul Airport, South Korea

<http://www.seouladex.com/intro.asp>

15-17 October

### MRO EUROPE

ExCel London, London, UK

<https://mroeuropa.aviationweek.com/en/home.html>

22-24 October

### NBAA BUSINESS AVIATION CONVENTION & EXHIBITION

Las Vegas Convention Centre, Henderson

Executive Airport, Las Vegas, NV, USA

<http://www.nbaa.org/events/bace/2019>

Thai Navy Chief Admiral Ruddit to India in December last year. The two sides are likely to sign a sale contract next year.

## INDIA TO BUY R-27 AIR-TO-AIR MISSILES FOR \$218 MILLION

India has reportedly paid approximately \$218 million to buy a batch of R-27 air-to-air missiles. The missiles will be equipped on the SU-30MKI aircraft of the Indian Air Force. The missiles have been acquired under 10-I (ten days at intense rate of expenditure) projects, which mandate the three services to maintain critical weapon systems and spares for a specified minimum period. The R-27 is a medium-to-long-range air-to-air missile developed by Russia for its MiG and Sukhoi series of fighter jets. Russia developed these missiles to add capability to the Sukhoi and MiG warfare aircraft. The Indian Air Force has signed \$1.1 billion deals in the past two months. These deals were supposed to acquire equipment under emergency requirements.

## POSSIBLE FMS SALE OF F16 TO PAKISTAN

The US Government has announced a possible FMS to Pakistan for continued support of the F-16 programme. The FMS is valued at \$125 million. The Government of Pakistan had requested a continuation of technical support services, US Government and contractor technical and logistics support services and other related elements of logistics support to assist in the oversight of operations in support of the Pakistan Peace Drive advanced F-16 programme. Pakistan has used the F-16 fighter jets against India, the latest being in the aftermath of the Balakot airstrike inside Pakistan by India. The programme raised the total number of F-16s ordered by Pakistan to 54. The Pakistan Air Force received its first F-16, in the block 15 F-16A/B configuration, in 1982. ●

## QUICK ROUNDUP

### ADVANCED ELECTRONICS

Advanced Electronics has won a \$57.8 million modification for the Royal Saudi Air Force F-15SA Cyber Protection System and Related Facilities programme. The F-15SA multi-role fighter is an advanced variant of the Boeing F-15 Strike Eagle supplied to Saudi Arabia. It has a modern, fly-by-wire flight control system in place of the hybrid electronic/mechanical system used by previous F-15s. Work is expected to be completed by July 31, 2022.

### MARSHALL AEROSPACE AND DEFENCE GROUP

The British defence company Marshall Aerospace and Defence Group rolled out the first of a number of C-130J Hercules aircraft it is preparing for delivery to Bangladesh Air Force, during an official ceremony last week. Marshall is carrying out comprehensive depth maintenance and important modifications on all the aircraft including capability enhancements such as MEDEVAC, avionics upgrades and the provision of a Passenger Transport Configuration.

### PHILIPPINES

Philippines has announced that pilots and maintenance personnel are now in Jordan to train on operating the AH-1 attack helicopter. Jordan had donated two AH-1 attack helicopters to the Philippines. In 2010 Jordan transferred 16 AH-1F helicopters to Pakistan, under a US-sponsored support programme that provided Islamabad with 40 AH-1 refurbished helicopters.

### TURKEY

According to local reports, Turkey plans to use air-to-surface missiles initially developed for the F-35 on locally developed national combat aircraft and drones. Turkey's industry and technology Minister, Mustafa Varank said that the SOM-J cruise missile jointly developed by the US and Turkey, will be deployed on local air assets following Ankara's exclusion from the F-35 programme.

It has been reported that Turkey's Advanced Jet Trainer and Light Attack Aircraft Hürjet project has been successfully finalised. Hürjet is a single engine, tandem-seat aircraft with modern avionics and high-performance features. It has a combat version also.

## APPOINTMENTS

### AIRBUS DEFENCE AND SPACE

Airbus Defence and Space has announced the appointment of Julian Whitehead as Executive Vice-President Global Business and Strategic Programmes, effective October 1, 2019.

# FAILURES ARE THE **PILLARS OF** **SUCCESS**



Even if the Chandrayaan-2 mission is regarded as a failed mission, it would yield valuable lessons for ISRO for its next attempt at soft landing on the Moon.

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

**THE CHANDRAYAAN-2, A MISSION UNDERTAKEN BY THE INDIAN** Space Research Organisation (ISRO) to carry out a soft landing on the Moon in its South Pole region by a space vehicle named as Vikram that carried a Rover named as Pragyan, was meant for exploration of the Lunar surface. The mission was launched on July 22 this year from the Satish Dhawan Space Centre located on the island of Sriharikota off the coast of Andhra Pradesh in the Bay of Bengal. After a journey lasting for 48 days, on 07 September, while approaching for a landing on the surface of the Moon, when the Lander Vikram was just 2.1 km from its landing site, it apparently encountered a technical glitch that resulted in total loss of communication with the ISRO Satellite Control Centre. At this stage, it is difficult for ISRO to state precisely as to what went wrong. However, as per a statement issued by the organisation, they will be in a position to identify the problem that led to the failure of the mission in the last minute and take appropriate corrective action for the next mission.

The Chandrayaan-2 mission was preceded by Chandrayaan-1, the first lunar probe undertaken by ISRO under the Chandrayaan programme. It was launched by ISRO on October 22, 2008 using a PSLV-XL rocket and included a lunar Orbiter and a Moon Impact Probe. The Chandrayaan-1 was inserted into lunar orbit on November 08, 2008 and on November 14, the Moon Impact Probe separated from the Chandrayaan orbiter and struck the South Pole in a controlled manner, making India the fourth country in the world to make its mark in the domain of lunar exploration.

While the way mission Chandrayaan-2 is being projected in some quarters as having come to a sudden end and is generally being perceived as a failure, which is likely to generate a wave of disappointment across the nation, the fact is that so far, there is no clear cut evidence to prove or even suggest that the Lander Vikram has actually crashed on the lunar surface. All that we know so far is that there has been a breakdown of communication between the Lander Vikram and the satellite control centre at ISRO. There is still a possibility that the Lander Vikram could have landed at the planned site on the South Pole of the Moon. Whether this is so or whether the Lander Vikram along with the Rover Pragyan has crashed in the vicinity of the proposed landing site, can be confirmed by images captured by the high definition cameras on board

the Orbiter which is still functional and in orbit around the Moon. ISRO is expected to release a news bulletin on this in the near future.

What needs to be understood at this stage is that the Chandrayaan-2 mission had two parts. The first part which is 95 percent of the task, is to be performed by the Orbiter which has an orbital life of one year. During this period, the Orbiter will continue taking high resolution pictures of the lunar surface and transmit these to the satellite control centre at ISRO. The second part of the mission which constitutes only five percent of the task, was to carry out a limited exploration of the lunar surface by the Rover Pragyan essentially to establish the presence of water in liquid form or in the form of ice. Compared to the Orbiter, the Rover Pragyan had a life of mere 14 days. If one still insists on regarding mission Chandrayaan-2 as a failure, then it would be more appropriate to define it as a failure by only five percent.

A successful soft landing on the surface of the Moon would have made India the fourth country in the world after the United States, Russia and China to have achieved this feat! What is also noteworthy is that the cost of the Chandrayaan-2 mission is about \$140 million which compared to cost of similar projects by other nations is very low. The Chandrayaan-2 mission is also extremely important for ISRO as it holds great significance for future space exploration missions, including those to Mars.

In this mission under discussion, the Lander Vikram came very close to the lunar surface after a long and complex journey involving transit from orbital path around the Earth to that of the Moon. This itself reflects a high degree of professional capability as well as achievement by the scientific community at ISRO through what has been a totally indigenous effort. Carrying out a soft landing on the Moon is an extremely complex and difficult task. Of the 38 attempts that have been made by the leading space faring nations of the world in the last few years, only 50 percent have been successful.

In the final analysis, even if the Chandrayaan-2 mission is regarded as a failed mission, it would yield valuable lessons for ISRO for its next attempt at soft landing on the Moon. After all, we cannot ignore the old adage that failures are the pillars of success! **SP**



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Narendra Modi, Hon'ble Prime Minister of India (\*message received in 2014)



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