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SHAPE of FUTURE

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AERIAL TECHNOLOGIES AND THEIR IMPACT ARE RESHAPING THE FUTURE WARS

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COVER IMAGE
The CCA (Collaborative Combat Aircraft) programme of USAF aims to be operating in collaborative teams with the next generation of manned combat aircraft.

*(**Cover Photo**: General Atomics Aeronautical Systems)*

COVER DESIGN BY: *SP's Team*

NEXT ISSUE: *EBACE 2024*

After the Indian Space Policy in 2023, IN-SPACe's recent norms and guidelines aim to further streamline implementation of the Policy, encouraging private sector participation in satellite and ground station activities. Although the policy is not yet a binding law, it has spurred growth, attracting numerous startups and substantial funding.

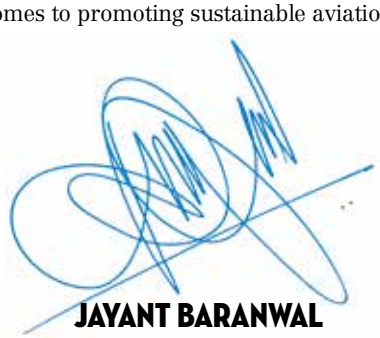
THE GLOBAL SPACE SECTOR IS BUZZING WITH ACTIVITY, AND India's space industry stands out with remarkable growth in the past year, spanning industrial, technological, and policy advancements especially since the Indian government opened the space industry to private players in 2020. Despite the challenges ahead, new initiatives are streamlining processes and improving business accessibility. The liberalisation of FDI regulations, permitting up to 100 per cent FDI in certain areas, further boosts the sector. However, a clear legal and regulatory framework to support private sector growth is required to help India capture a significant share of the global space economy. A report by Ayushee Chaudhary in this edition of the magazine, takes a brief look back at these advancements and how the Indian space industry is faring. This edition also highlights Pakistan's recent satellite launch, iCUBE-Q, aiming to collect samples from the far side of the moon. This mission underscores the deepening collaboration between Pakistan and China, which began in 1991.

Advances in military aviation technologies are further set to shape the battle skies of tomorrow. Military aviation is embracing a revolution driven by cutting-edge technology. Artificial intelligence (AI) is at the forefront, assisting with autonomous operations, intelligent navigation, and even weapon selection. Unmanned Aerial Systems (UAS), or drones, are rapidly evolving, taking on roles from aerial reconnaissance to combat missions. Advanced pilot support systems utilising AI and enhanced displays are improving pilot decision-making and situational awareness. Additionally, next-generation fighter jets boast features like advanced radars and even laser weaponry, redefining aerial combat. These are just a glimpse of the exciting advancements transforming the skies and shaping the future of military aviation. Air Marshal Anil Chopra (Retd) gives a quick overview of these emerging technologies in aerial combat.

This issue also features the Embraer C-390 Millennium, whose achievements are expanding the footprint of Embraer Defense & Security products and solutions across borders. Embraer C-390 Millennium multi-mission aircraft's reputation for unmatched mobility, operational flexibility, and low operating costs is attracting international attention. Recent orders from countries like South Korea, Hungary, and Austria solidify its position as a leader in the medium-sized military transport market. This versatile aircraft is poised to become a mainstay in air forces worldwide, revolutionising military transport capabilities across the globe.

In a race towards a net-zero future, global airlines are deploying a multi-pronged attack. Biofuels are being championed, with airlines investing in research and incorporating them into their fuel mix. Modernisation reigns supreme, as airlines update their fleets with fuel-efficient aircraft and implement operational tweaks for optimised flight paths and eco-driving practices. Waste reduction is also a key focus, with comprehensive recycling programmes minimising onboard and ground emissions. Some airlines are even exploring future technologies like electric and hydrogen-powered aircrafts for a truly sustainable future. Joseph Noronha explores the airline industry's efforts to promote sustainability, while Rohit Goel emphasises the need for a collaborative effort in India to address challenges related to feedstock availability, cost competitiveness, policy frameworks, and technological advancements when it comes to promoting sustainable aviation.

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



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INDIA'S REUSABLE LAUNCH VEHICLE TO BE CALLED PUSHPAK

A GROWING & EXPANDING SECTOR

While the space sector is on an upward trajectory with the Indian Space Policy, FDI liberalisation and the recent authorisation guidelines, the success of these initiatives hinges on a clear legal and regulatory framework to support the industry.

By **AYUSHEE CHAUDHARY**

INDIA'S BURGEONING SPACE SECTOR IS RAPIDLY EXPANDING, brimming with promising potential. Since the government's landmark decision to open the space industry to private players in 2020, the sector has experienced quite unprecedented growth, success, and organisational development.

Although there is still a long road ahead, initiatives are consistently being introduced hoping to streamline industry processes, improve accessibility, and enhance the ease of doing business in this sector that's growing nearly at the speed of light. The latest of these initiatives is the unveiling of norms, guidelines, and procedures (NGP) by the space regulator IN-SPACe. These measures aim to effectively implement the Indian Space Policy 2023, inviting private players to engage in activities ranging from building and launching satellites to setting up ground stations and sharing remote sensing data.

The Indian Space Policy, introduced last year, aims to integrate the private sector into the space industry and stimulate their active participation. Although the policy has yet to be formalised into binding law, it has already spurred significant growth, with numerous startups entering the ecosystem and existing space companies securing substantial funding. Additionally, the recent introduction of the NGP follows the government's liberalisation of the Foreign Direct Investment (FDI) regime for the sector, permitting up to 100 per cent FDI via

PHOTOGRAPH: PIB

(LEFT-RIGHT): CHANDRAYAAN LAUNCH AND THE SATELLITE.
CHANDRAYAAN MISSION WAS A LANDMARK IN THE HISTORY OF INDIA'S SPACE EXPLORATION.

the automatic route for specific sub-segments within the space industry. This progressive move is set to attract more foreign investment and drive further advancements in India's space endeavors.

Here's a brief look back at these advancements and how the Indian space industry is fairing.

INDIAN SPACE POLICY 2023: THE WATERSHED MOMENT

Released in April 2023, the Indian Space Policy marked a significant milestone, encouraging private sector involvement across the space industry. There are 189 DPIIT-recognised space technology startups in India, and the space startups have garnered investment worth $124.7 million during March-December 2023, underlines Invest India. Various Indian space startups like Dhruva, Digantara, Pixxel, Skyroot and others have attracted major investors, securing significant funding last year.

The policy also aims to foster collaboration between researchers, academicians, startups and the industry. Enhancing space capabilities, expanding commercial space activities, and creating a supportive ecosystem for all stakeholders are some major goals stated in the policy document. The policy also delineates the roles and responsibilities of the stakeholders, briefly as follows:

- **Department of Space (DoS):** Shall oversee the policy's implementation, ensuring stakeholders are empowered without overlap.
- **ISRO:** Shall focus on R&D of new space technologies, human spaceflight capability, and sustaining human presence in space. Routine tasks will transition to industry partners.
- **Indian National Space Promotion and Authorisation Centre (IN-SPACe)**: Shall acts as a single-window agency for authorising space activities by government and non-government entities (NGEs), coordinating with relevant government departments for communication services.
- **NewSpace India Limited (NSIL):** Shall continue to commercialise space technologies developed through public funding, facilitate manufacturing and procurement of space assets, and conduct commercial missions with ISRO.

S. Somanath, Chairman, ISRO and Secretary, DOS had explained to *SP's Aviation* earlier that over the years, whatever has been created on the space side has been through R&D done by ISRO but in addition to that the ISRO scientists had to look into the integration of those systems as well. "While it helped in understanding how to make better systems; the scientists' temperament needs to be invested more towards researching & developing more advanced systems. So going further, a balance is being sought. The development will continue even in terms of integration at ISRO but what is routine i.e. matured systems, will go to the industry. ISRO will continue to have similar tasks and look into bringing in new platforms, new approaches, and improvements of the existing platforms both in launch vehicles and the satellites."

The policy encourages NGEs to develop and operate space transportation systems, build launch infrastructure, engage in space exploration, and pursue commercial asteroid resource recovery. The policy also promotes the development of space

PHOTOGRAPHS: ISRO

(ABOVE ALL): PRIME MINISTER NARENDRA MODI DURING HIS MAIDEN VISIT TO VIKRAM SARABHAI SPACE CENTRE (VSSC), THIRUVANANTHAPURAM OF ISRO, THE MOTHER CENTRE OF THE INDIAN SPACE PROGRAMME.

situational awareness (SSA) capabilities and underscores space's role in India's socio-economic development, environmental protection, peaceful exploration of outer space, public awareness, and scientific research.

While India aims to capture a significant share of the expanding trillion-dollar global space market, its policy contrasts with those of other space-faring nations, which often address security concerns more explicitly. In line with India's space programme that has historically been civilian-focused, the Indian Space Policy signals a commitment to expanding India's presence in space, primarily focusing on civilian initiatives and scientific exploration, with limited mention of security. The emphasis on human spaceflight and celestial resource exploration suggests potential support for long-awaited missions like Gaganyaan and Chandrayaan. However, further policy development is needed to fully realise India's space ambition and given the dual-use of space, a defence-oriented space security policy may be forthcoming. Additionally, while the policy looks like a great first step, it has a long way to go in terms of turning this from a statement of intent to a binding regulatory framework.

According to the Indian Space Policy 2023, IN-SPACe will provide authorisations to both government bodies and NGEs for space activities, such as establishment and/or operation of space objects, launch of rockets, establishment of launchpads, planned re-entry of space objects, and so on. To further clarify on the authorisation, IN-SPACe has released the NGP document, about one year after the Policy was released.

AUTHORISATION GUIDELINES

In May 2024, IN-SPACe released 'the NGP for implementation of Indian Space Policy 2023 in respect of Authorisation of Space Activities' document. The norms pertain to the rules regarding authorisation for space activities in the country. The document lists out space activities that need authorisation from IN-SPACe, specifies criteria for granting such authorisations and provides necessary guidelines/pre-requisites to be fulfilled by an applicant for making an authorisation application.

According to the NGP document, any entity, whether Indian or foreign, carrying out space activities from Indian territory, its exclusive economic zone, or within its jurisdiction, needs authorisation from IN-SPACe. The guidelines detail various space-related activities that need authorisation and outline various criteria mandatory to seek appropriate approvals. The authorisation is required for a wide range of activities, including launching, operating, guiding, planning re-entry of space objects, establishing communication and remote sensing satellites, hosting payloads, operating space transportation systems, and disseminating high-resolution remote sensing data pertaining to Indian territory, sale of in-orbit space objects, among others.

The applicants have to fulfill various criteria such as technical obligations and specify budgets, risk mitigation measures and aspects related to pricing. The guidelines also delineate that only Indian entities can apply for authorisation from IN-SPACe, "Only an Indian entity can apply to IN-SPACe seeking authorisation. Non-Indian entities desiring to conduct space activity in India can apply to IN-SPACe for authorisation through an

PHOTOGRAPHS: PIB

Indian entity which could be its Indian subsidiary, joint venture or any other collaboration arrangement recognised by the Government of India," noted the guidelines.

"However, the authorised representative/dealer of non-Indian entities can seek IN-SPACe authorisation for certain category of authorisations such as authorisation of non-Indian GSO and/or NGSO satellite/constellation to enable provisioning of its capacity in India for communication services, dissemination of space-based earth observation/remote sensing data, etc," the document adds. It also outlines the process for registering space objects in India's national registry and makes it mandatory for operators to provide detailed information about their space objects, ensuring compliance with space debris mitigation guidelines and operational safety protocols. Not just this, the norms also mandate that applicants have to inform IN-SPACe about any change in their 'management and control' or shareholding pattern within 48 hours. In the instance where the control of the authorised entity is passed to a foreign company, the company will have to apply for fresh authorisation. Additionally, the approvals are also subject to the national security regulations and the norms bar activities that pose a "threat to national defence, intelligence and security operations, foreign relations, public order, the safety of people or their property, and protection against natural disasters".

Non-compliance with the guidelines and applicable local laws may result in revocation of the authorisation by IN-SPACe, added the document. "IN-SPACe may impose control on operations of the authorised space objects and space activities or terminate/suspend the authorisation, during national emergencies or in the interest of national security, such as situations arising out of or due to conflicts or natural disasters or times of emergency."

The rules also envisage penalties in case an applicant "unilaterally discontinues/ terminates/ withdraws the provision of services" during the tenure of the approval depending on the nature of the loss, damage, impact on Indian users due to "discontinuation of service, expenses or any harm or prejudice to the interests of India's national security caused by such actions of the applicant".

The applicants will also have to take measures to reduce the generation of space debris under the applicable Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space (UN-COPUOS) (2007). During the mission planning stages, the private party needs to determine collision risk based on the background Space Object density during the transit phase.

While certain subject matter experts do find some gaps in the guidelines, largely the NGP intends to help stakeholders to better understand the regulations and streamline the activities from building, launching and setting up ground stations.

FOREIGN DIRECT INVESTMENT

IN FEBRUARY 2024, GOVERNMENT APPROVED 100 PER CENT FDI through the automatic route for manufacturing satellite components, ground segments, and user segments. The amended FDI policy now allows up to 100 per cent FDI in various space-related activities under different subcategories, with defined investment limits:

- Up to 100 per cent FDI for manufacturing satellite components, ground segments, and user segments.
- Up to 74 per cent FDI for manufacturing and operating satellites, satellite data products, etc, with government approval needed beyond this threshold.
- Up to 49 per cent FDI for launch vehicles, associated systems, and creation of spaceports, with government approval required beyond this limit.

This liberalisation is also expected to foster innovation, generate employment, and enhance India's self-reliance in the space sector. This increased private sector participation is anticipated to bring modern technology and necessary funds into the ecosystem. SP

WAY FORWARD

According to a latest report by World Economic Forum, the space economy is forecast to reach $1.8 trillion by 2035, up from $630 billion in 2023 and growing at an average of nine per cent per annum – well above the growth rate of global gross domestic product (GDP). The space industry is standing at an inflection point. The Indian space economy has seen an explosion of activity, notably a lunar programme that has made India the first country to land a spacecraft near the lunar south pole.

"India has witnessed investment of over ₹1,000 crore in Space Startups in the last nine months of the current financial year from April to December 2023. The investment in Indian Space Startups has increased to $124.7 million in 2023," the Union Minister of State (Independent Charge) Science & Technology, Dr Jitendra Singh said. He further added, the current size of the Indian Space Economy is estimated around $8.4 billion and it is expected that with the implementation of the Indian Space Policy 2023, $44 billion Indian space economy can be achieved by the year 2033.

"The past year has been a transformative period for the Indian space sector, especially for startups. With pivotal changes like the liberalisation of FDI policies, a streamlined authorisation process, and a more structured approach to space activities, we've entered an era of opportunity and innovation. This evolving landscape enables startups like Digantara to accelerate their missions, contributing to India's ascent as a global space powerhouse," said Anirudh Sharma, Founder, and CEO, Digantara. "With that said, the encouragement for space startups will effectively translate into reality once these broad policy measures are complemented by a clear and well-defined legal and regulatory framework, which will promote a favorable environment for industry stakeholders."

To streamline private sector participation, DoS established IN-SPACe to provide authorisations, infrastructure support, and technical assistance to NGEs, promoting a conducive environment for space activities, Dr Jitendra Singh further highlighted. NSIL, ISRO's commercial arm, facilitates manufacturing, leasing, and trading of space assets, enhancing India's commercial space capabilities. In line with the reforms, NSIL has also been taking demand-driven missions and working towards collaborating with Indian Industries towards productionising ISRO's launch vehicles.

Further with increasing participation from space-tech startups and NGEs, the sector is on an upward trajectory. However, the success of these initiatives hinges on a clear legal and regulatory framework to support the industry. India aims to capture 10 per cent of the global space economy, which requires incentivising private sector growth. In addition to the policy's direction, FDI liberalisation and the recent authorisation guidelines, the implementation needs clarity, especially regarding the roles of regulatory agencies and converting this policy into a practical regulatory framework will require significant immediate effort.

At this pivotal juncture, with a history of cost-effective innovation, a burgeoning private sector, and supportive regulations, India is poised for significant advancements in the space industry. SP

CHANG'E 6 LUNAR MISSION SUCCESSFULLY LAUNCHED WITH PAKISTAN'S ICUBE-Q ONBOARD

PAKISTAN ORBITING BACK INTO SPACE EXPLORATION

In a first, Pakistan's satellite, iCUBE-Q, was launched on May 3, 2024 to orbit the moon as part of China's Chang'e-6 lunar mission

By AYUSHEE CHAUDHARY

PHOTOGRAPH: KHALILHASHMI / X

IN A FIRST FOR THE COUNTRY, PAKISTAN'S SATELLITE, ICUBE-Q, was launched on May 3, 2024 to orbit the moon as part of China's Chang'e-6 lunar mission. Led by the China National Space Administration (CNSA), the mission targets the South Pole-Aitken Basin to gather dust and rock samples, providing invaluable insights into the composition and characteristics of this lunar region. Weighing about 7 kg, Pakistan's maiden lunar satellite iCUBE-Q was developed through collaboration between Pakistan's Institute of Space Technology (IST) and China's Shanghai University.

ICUBE-QAMAR

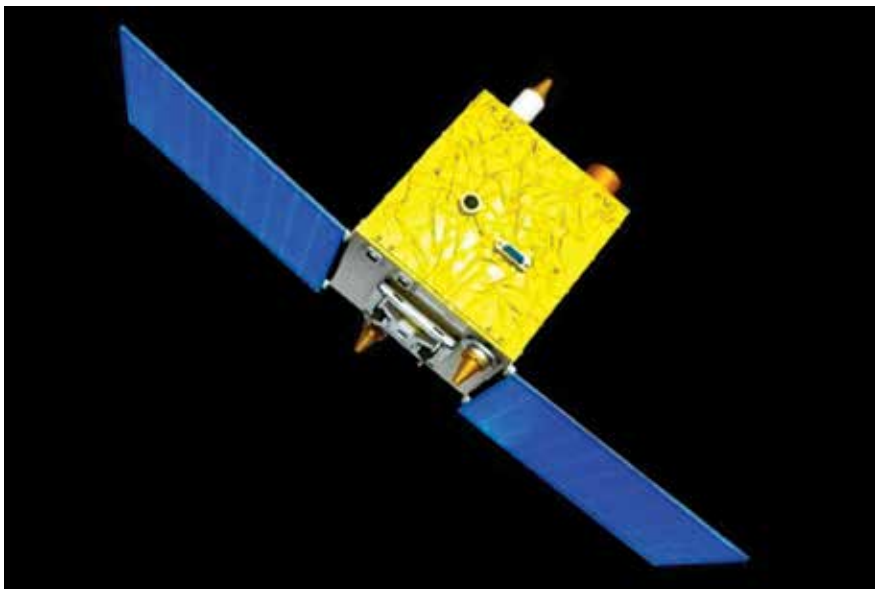
Riding aboard the Chang'e-6 probe, the iCUBE-Qamar was deployed from the Chang'e-6 spacecraft on May 8. The iCUBE-Q orbiter carried two optical cameras to image the lunar surface. Alongside capturing images, the iCUBE-Q orbiter is also collecting valuable data on the lunar magnetic field and laying the groundwork for future missions and international collaborations. The data collected by this miniature satellite will provide valuable insights into the Moon's topography, geological features, and potential resource deposits.

The module is a cube satellite or CubeSat. CubeSats, categorised as nanosatellites, follow standardised size and form factors, typically beginning with a "one unit" or "1U" size measuring 10x10x10 cm but extending to larger sizes like 1.5U, 2U, 3U, 6U, and 12U. Their development has burgeoned into a thriving industry, with collaboration among government, industry, and academia aimed at enhancing their capabilities. CubeSats provide a cost-effective platform for various purposes, including scientific research, technology demonstrations, and innovative mission concepts like constellations and swarms. These miniature satellites, primarily cubic in shape, consist of modular components that adhere to specific size constraints and weigh only a few kilograms, primarily serving scientific research and educational initiatives in space exploration. iCUBE-Q is aimed to support scientific research,

> The Chang'e-6 rocket took five days to reach the moon's orbit, deploying iCUBE-Qamar on May 8 into a meticulously chosen 12-hour elliptical orbit

technological advancement, and educational endeavors within the realm of space exploration for Pakistan.

China's Chang'e-6 mission aims to explore the far side of the Moon and collect up to 2,000 grams of lunar material for analysis upon its return to Earth. As part of the mission, the Chang'e-6 lunar probe carries payloads from various international partners, including the European Space Agency (ESA), France, and Pakistan, showcasing collaborative efforts in space exploration. This mission also follows China's successful return of samples from the Moon's near side in 2020.



SATELLITE ICUBE-Q WAS DEVELOPED THROUGH COLLABORATION BETWEEN PAKISTAN AND CHINA

CAPTURING THE MOON & SPACE EXPLORATION

iCUBE-Q, transmitted its initial images from orbit after completing three lunar orbits successfully. Released by the Space and Upper Atmosphere Research Commission (SUPARCO), Pakistan's Space Agency, the data was transmitted by the CubeSat and delivered to Pakistan by China. The Chang'e-6 rocket took five days to reach the moon's orbit, deploying iCUBE-Qamar on May 8 into a meticulously chosen 12-hour elliptical orbit, enabling imaging of targeted lunar surfaces. Pakistan's CubeSat project achieved the set goal of successfully separating and obtaining telemetry' and achieved complete success, the CNSA announcement said.

The images, captured between May 8 and 9, offer a glimpse of the lunar surface, showcasing the details of its rugged terrain and craters. The first image showed the sun as a bright spotlight; the second was that of a sparkling half moon while the third image showed the moon on the left and the sun on the right. One particularly striking image depicts the Earth's natural satellite alongside the Sun. The images were unveiled at a ceremony organised at CNSA to mark the successful mission, and were then officially handed over to Pakistan's ambassador to China.

In 2022, CNSA offered an exclusive opportunity to member states of the Asia Pacific Space Cooperation Organisation (APSCO) to include a student-designed payload on the Chang'e 6 mission to the moon. Pakistan's iCUBE-Q was selected through that.

PAKISTAN'S SPACE SOJOURN

Pakistan's foray into lunar exploration marks a significant step forward for the nation's space programme. China's burgeoning space exploration programme underscores its emergence as a formidable competitor in the global space race. Concurrently, Pakistan is also restarting to make strides in space exploration with iCUBE-Q its inaugural lunar mission. This mission follows closely on the heels of India's Chandrayaan-3 soft-landing on the moon's south pole about nine months back.

Pakistan's space agency, SUPARCO, founded in 1961, has faced challenges including funding constraints and misplaced priorities, resulting in limited progress especially compared to India's ISRO (Indian Space Research Organisation) that started in 1969. Pakistan's inaugural National Space Policy coming out at the end of 2023, marked a pivotal moment in its scientific journey, aligning with global trends in space privatisation amidst geopolitical complexities. Despite historical challenges, including economic constraints and political instability, Pakistan aims to leverage its new policy to overcome obstacles.

Pakistan's space aspirations are embodied in its Space Programme 2040, later renamed Space Vision 2047, launched in 2011. Embracing private sector involvement and emphasising international collaboration, Pakistan seeks to position itself as an emerging space economy. To further advance its space programme, Pakistan must prioritise public-private collaborations, establish global partnerships, invest in STEM education, and develop a supportive legislative framework. Initially partnering with NASA (National Aeronautics and Space Administration) at the beginning of its space programme, Pakistan eventually shifted its focus to China leading to stronger bilateral collaboration. Despite challenges like budget cuts and a lack of expertise, recent efforts bring some hope to revitalise Pakistan's space programme.

"Pakistan's space agency, SUPARCO, founded in 1961, has faced challenges including funding constraints and misplaced priorities, resulting in limited progress especially compared to India's ISRO (Indian Space Research Organisation) that started in 1969."

PAK-CHINA SPACE COOPERATION

As China and Pakistan journeyed towards the moon, the iCUBE-Q mission also emphasised strengthening lunar exploration collaboration between the

PHOTOGRAPH: WIKIPEDIA

CHINA HANDS OVER PAKISTANI CUBESAT DATA FROM CHANG'E-6 MISSION TO PAKISTAN

two nations. However, this collaboration is not new. Beginning its space journey with the establishment of SUPARCO in 1961, Pakistan collaborated with NASA to launch its first communication satellite, Rehbar-1, in June 1962. Bilateral collaboration between Pakistan and China commenced in 1991 and has since strengthened, with proposals to integrate space cooperation into the China-Pakistan Economic Corridor (CPEC) through a "silk space road." In 1990, Pakistan launched the Badr-1 satellite from China's Xichang Satellite Launch Center using a Long March 2E rocket.

> The data collected by this miniature satellite will provide valuable insights into the Moon's topography, geological features, and potential resource deposits

In space, Sino-Pakistani cooperation also extends to Intelligence, Surveillance, and Reconnaissance (ISR) and satellite navigation services. Since 2013, Pakistan has been integrated into China's BeiDou Satellite Navigation system. Pakistan operates satellites like the Pakistan Remote Sensing Satellite-1 (PRSS-1), launched by China in 2018, and the PakTES-1A, developed by SUPARCO and in 2020, China agreed to establish a BeiDou-linked CORS in Pakistan. This collaboration enhances Pakistan's missile forces' accuracy and penetrability. China's provision of the SLC-18 radar system, capable of detecting satellites and ballistic missiles, underscores the deep alliance between the two countries. Collaboration between CNSA and SUPARCO on a human spaceflight framework has also been indicated. In 2023, Pakistan also joined China's International Lunar Research Station.

In an era marked by renewed interest and fervent competition in space exploration, both nations are poised to contribute groundbreaking discoveries. As Pakistan sort of restarts its space journey, it is not only a display of its pursuit of scientific advancement in this subject but will also be critical in defining the dynamics of the already volatile geopolitical conditions, economic fluctuations and the growing space activities. SP

EXPERT'S VIEWS: CHINA-PAKISTAN SPACE COOPERATION

CHINA HAS A VERY ADVANCED SPACE PROGRAMME. PAKISTAN'S Space & Upper Atmosphere Research Commission (SUPARCO) was established in 1961. The agency had little to show in the initial 30–35 years. The country's first technology-demonstrator satellite, Badr-I, was built by SUPARCO, and launched by China in 1990. SUPARCO played a significant role in the development of Pakistan missiles such as Hatf-I and Hatf-II that was supported by China based on its M-11 missile. Pakistan does not have its own launch vehicles and aims to launch more satellites with Chinese help. Since 1992, China has helped Pakistan develop and launch communications satellites and remote sensing satellites, among others.

Pakistan Remote Sensing Satellite (PRSS) programme was planned to be a progressive and sustainable programme with an initial plans to launch an optical satellite with payload of 2.5 metre PAN in 700 km Sun-synchronous orbit by the end of year 2014, which was to be followed by a series of optical and SAR satellites in future. The programme finally got going in 2018, when China launched two remote sensing satellites for Pakistan, which were to monitor progress of the China–Pakistan Economic Corridor. The satellites were named PRSS-1 and PakTES-1A. The PRSS-1 is China's first optical remote sensing satellite sold to Pakistan. The PakTES-1A is an experimental satellite developed by SUPARCO.

The two nations signed a series of space exploration agreements in 2019 as part of China's Belt and Road Initiative. They include China helping to train Pakistani astronauts and send them into space, and to the newly completed Tiangong space station in low-Earth orbit. Pakistan has access to the Chinese BeiDou satellite navigation system. iCUBE-Q, a scientific experimental Pakistani CubeSat was launched aboard China's Chang'e-6 lunar probe on May 3 and has beamed first images. It is also the first satellite collaboration mission between Pakistan and China as well as the universities. A symbol of mutual trust, and youngsters' exploration of the moon. The debt-ridden Pakistan has very little to invest in space programme currently and will remain dependent on China for years ahead. SP

— Air Marshal Anil Chopra (Retd), former Director-General, Centre for Air Power Studies

PHOTOGRAPH: CNSA

EMIRATES IS THE WORLD'S FIRST AIRLINE TO OPERATE A380 DEMONSTRATION FLIGHT WITH 100 PER CENT SUSTAINABLE AVIATION FUEL

SUSTAINABILITY — A BIG MILESTONE

A steely-eyed focus on sustainability is fundamentally altering the way the airline industry operates. But the pace of progress in both SAF and engine enhancement must be greatly accelerated to make net zero a reality.

By JOSEPH NORONHA

COMMERCIAL FLIGHT IS THE ONLY VIABLE OPTION FOR transporting large groups of people quickly over large distances. The aircraft that do this burn fossil fuel, which is packed with energy but releases carbon dioxide (CO_2) and nitrogen oxides (NOx) into the atmosphere when burnt. While there has been tremendous progress in increasing fuel efficiency and curbing emissions over the decades, aviation is currently responsible for 2.5 per cent of global greenhouse gas (GHG) emissions. In addition, aviation condensation trails (or contrails) that contain ice crystals as well as water vapour, soot and sulphate aerosols contribute significantly to global warming in ways that are still being assessed. While other highly emissive industries like energy, road transport, and steel and cement manufacturing are gradually going green, air travel is extremely hard to decarbonise. Hence its relative share of emissions is expected to rise. But what makes the picture truly worrisome is that air traffic is surging across the globe, so aviation's emissions could well triple by 2050.

PHOTOGRAPH: EMIRATES

Acutely aware of the looming possibility that commercial aviation could effectively become environmentally unsustainable, in October 2022, member states of the International Civil Aviation Organization (ICAO) agreed to a long-term aspirational goal (LTAG) of net zero emissions from aviation by 2050. Net zero means the amount of GHG removed from the atmosphere is equal to that emitted by that activity. A near-term milestone of reducing carbon emissions by five per cent by 2030 has also been formulated. So, what is the airline industry doing to promote sustainability?

AIMING AT EVERYTHING

Sustainable aviation is a multidisciplinary field that seeks to reduce aviation's environmental footprint through innovation and new practices. Some measures are fairly obvious and ongoing. For instance, thanks to airframe redesign and more fuel-efficient engines, a typical flight today generates just half the CO_2 it would have in 1990. Many airlines are resolutely getting rid of their older aircraft and investing in modern, fuel-efficient planes like the Airbus A320neo and the Boeing 787 Dreamliner. The A320neo offers approximately 15-20 per cent fuel savings compared to the older A320ceo aircraft.

However, rather than wait endlessly for new airliners, airlines are also striving to enhance operational efficiency and reduce emissions by optimising flight routes, minimising aircraft taxi times, and reducing weight. No sustainability measure is too small. Artificial intelligence (AI) can help avoid flight delays, reduce fuel consumption and select flightpaths that avoid or reduce contrail production. A relatively modest investment in new, lightweight seating can reduce aircraft weight and significantly lower emissions over time. Similarly, sustainable cabin practices can make a substantial contribution to going green. For instance, some airlines are reducing the use of single-use plastics because they generate huge amounts of GHG and create mountains of waste. They are striving to recycle on-board waste, and even aiming for more sustainable catering options.

Carbon offsetting programmes or "green fares" allow conscientious passengers to voluntarily offset the emissions from their flights by contributing to projects that reduce emissions, such as renewable energy installations or reforestation efforts. But recent revelations about dodgy offset accounting practices have reduced their appeal, and many airlines like JetBlue and EasyJet are moving away from offsets.

One clear indication of the seriousness with which the industry is striving for sustainability is that some airlines are integrating air travel with other modes of transportation to reduce emissions. For example, Lufthansa offers passengers combined air and rail tickets for convenient and eco-friendly short journeys.

SAVING WITH SAF

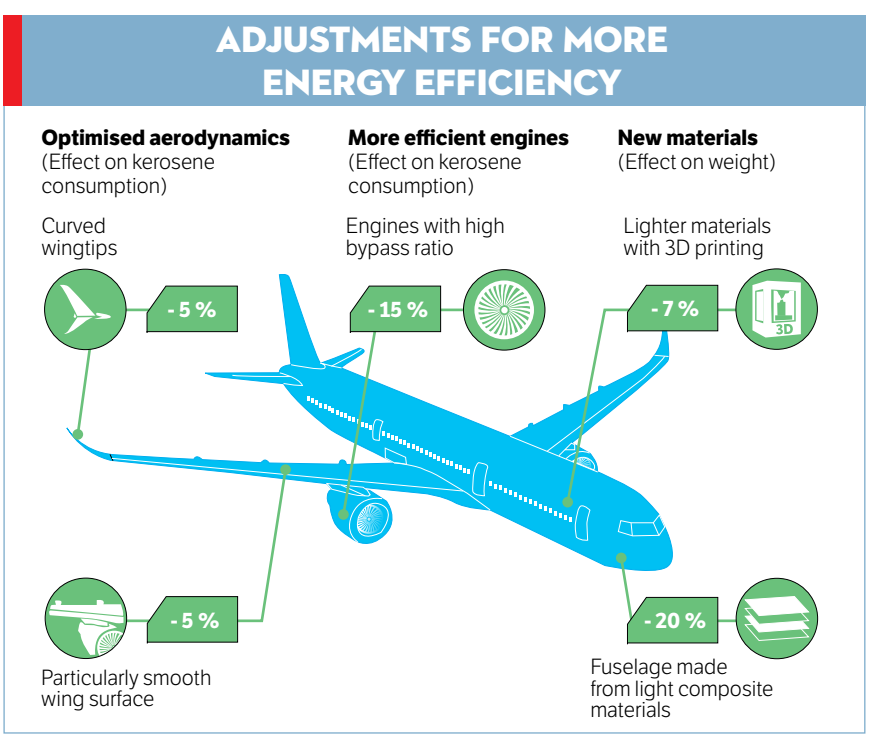
In the pursuit of sustainability, nothing holds greater potential than sustainable aviation fuel (SAF). SAF is a biofuel very similar in chemistry to traditional jet fuel. It promises up to 80 per cent reduction in carbon emissions compared to the fuel it replaces over the lifecycle of the fuel. SAF can be made from a variety of renewable biomass and waste resources, including corn, oilseeds, algae, waste oils and greases, and agricultural and forestry residues. Being a "drop in" fuel, SAF can be blended with normal fuel up to 50 per cent. Research is underway to permit even 100 per cent blending.

However, the widespread adoption of SAF is being hampered by limited availability and high cost. The International Air Transport Association (IATA) stresses that the airlines' demand for SAF "vastly exceeds" supply, which accounted for just 0.2 per cent of total jet fuel consumption in 2023. On average, SAF works out two to five times more expensive than traditional jet fuel. However, as the technology matures, and production volumes rise, it is expected to become more affordable.

The United States plans to produce over 11 billion litres of SAF by 2030 compared to just 16 million litres in 2022. Europe will legally require six per cent of all aviation fuel to be SAF, up from two per cent today. In fact, more than 100 countries have agreed that aviation fuel in 2030 should be at least five per cent SAF blended. As of July 2023, 11 conversion processes for SAF production had been approved and others are under evaluation. SAF demand can be met only from both natural sources and eFuels. In view of limited natural feedstocks, two processes – Power-to-Liquid (PtL) and Sun-to-Liquid (StL) – are becoming increasingly important. PtL technology produces SAF using green electricity, water and CO_2. Sun-to-Liquid (StL) is a process that uses concentrated solar energy to create SAF from water and CO_2.

LEADING THE SUSTAINABILITY CHARGE

Several airlines are taking the lead in implementing innovative sustainability initiatives. These global leaders and employing specific strategies to create a greener future for air travel.

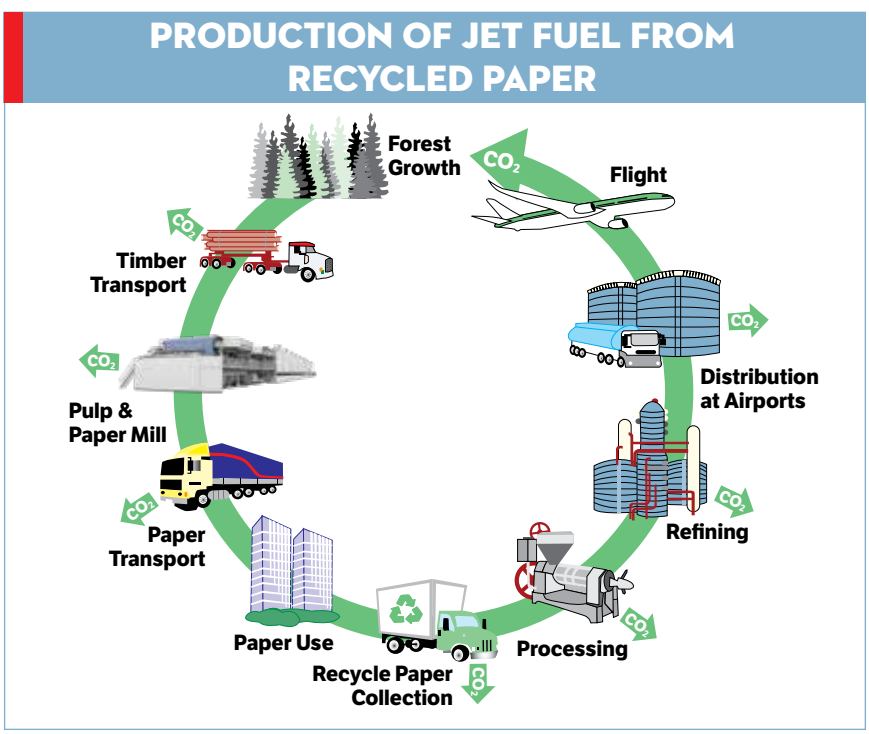


Source: BDL Aero

United Airlines. United plans to introduce a regional US flight service aboard 100 30-passenger hybrid-electric planes, from Swedish startup Heart Aerospace, by 2028. It's one of several innovative electric- and hydrogen-technology development partnerships that the airline is backing, while it's also invested in the production of 5 billion gallons of SAF, including biofuel sourced from microalgae – the largest airline commitment worldwide. United also recently rolled out a Sustainable Flight Fund that allows passengers and corporate partners to buy into SAF development, while its website now displays estimated CO_2 emissions alongside flight search results.

Alaska Airlines. While most major global airlines are targeting 2050 for net-zero carbon emissions, Alaska Airlines intends to meet that target as soon as 2040. To do so, the airline is laser-focused on fuel efficiency and has invested heavily in SAF (including CO_2-derived versions). It's also announced a partnership with the US-headquartered hydrogen-electric aircraft developer ZeroAvia to retrofit one of their regional aircraft as a hybrid hydrogen-electric plane. Customers will also notice single-use plastics reduction on board, like boxed water instead of plastic water bottles and paper cups instead of plastic ones; the line also composts select food waste like coffee grounds.

Air France KLM Group. The group is dedicated to accelerating its environmental transition and ensuring its position in a more sustainable aviation industry. The group has continued working on its trajectory to decarbonise all activities, formalising its action plan through 'Destination Sustainability.' By 2030, the group is committed to reducing CO_2 emissions per passenger-kilometre by 30 per cent compared to 2019 levels. Additionally, it has pledged to use at least 10 per cent sustainable aviation fuel by 2030, exceeding the 6 per cent requirement for departing European flights. To meet these targets, Air France KLM is taking action on multiple fronts: accelerating fleet renewal to reach 64 per cent new generation aircraft by 2028 (which offer a 20 to 25 per cent reduction in CO_2 emissions and a 34 per cent lower noise footprint), signing contracts and MoUs with several partners for the supply of Sustainable Aviation Fuel and supporting the development of the SAF sector in Europe.



Source: ResearchGate

Scandinavian Airlines. While many airlines have been teasing electric flights, Scandinavian airline SAS is the first to take seat reservations for commercial hybrid-electric flights in 2028, aboard 30-passenger Heart Aerospace planes on routes in Sweden, Norway and Denmark. The airline has ambitious targets that include slashing CO_2 emissions by 25 per cent by 2025, before phasing them out entirely in Scandinavia by 2030. The airline is backing various other clean-energy and SAF development projects, and has recently begun offering passengers dedicated fares that bundle in the direct purchase of biofuels, too.

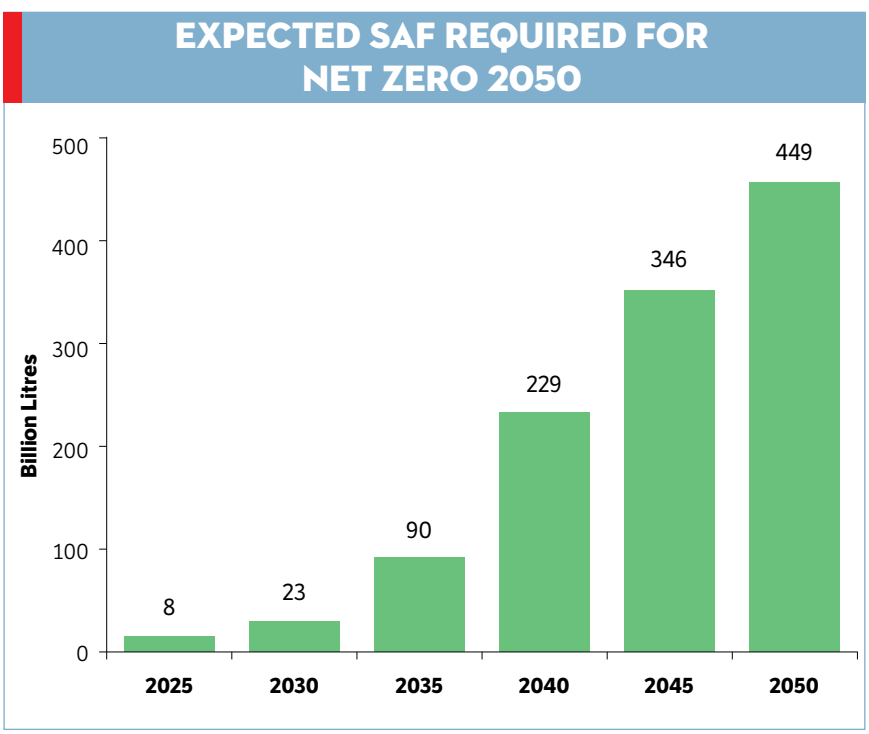
Etihad Airways. Etihad Airways has slashed CO_2 emissions by a quarter since 2019 thanks to improved operational efficiencies, and has also reduced single-use plastics by 80 per cent. The airline additionally partners with Boeing as part of the decarbonisation-focused "Greenliner" programme, using the carrier's fleet of Boeing 787 Dreamliners as testbeds for SAF and other eco-friendly technologies. Etihad has a similarly themed "Sustainable50" programme dedicated to its Airbus A350s. The airline is hoping to integrate SAF sourced from CO_2, while it has planted tens of thousands of carbon-absorbing trees as part of its Etihad Mangrove Forest project. Etihad was named the "Environmental Airline of the Year" for both 2022 and 2023 by an international rating agency.

Qatar Airways. Qatar Airways is the first airline in the Middle East to achieve the highest level of IATA's Environmental Assessment programme, demonstrating its commitment to managing environmental impact across all aspects of its business. Operating one of the youngest and most fuel-efficient fleets, the airline prioritises reducing carbon emissions through modern aircraft designs that produce lower emissions and less noise. Qatar Airways also invests in engineering upgrades for airframes and engines to reduce drag and improve efficiency. As the first airline in the Middle East to join the IATA Turbulence Aware data exchange platform, it ensures smoother journeys with lower fuel burn. Additionally, Qatar Airways has implemented over 80 fuel optimisation programs and identified opportunities to reduce fuel burn during all flight phases through Performance Based Navigation (PBN). Committed to advancing sustainable aviation fuel (SAF) despite challenges of accessibility and cost, the airline aims to use 10 per cent SAF by 2030.

Emirates. Emirates' policy of investing in the most modern, eco-efficient technology available means that the airline has one of the youngest fleets in the industry. All their aircraft meet the applicable ICAO engine emission standards. Emirates Engineering ensures that our engine washing procedures keep internal

engine components clean, maintaining fuel-efficient performance and having a clean aircraft exterior to help to reduce fuel consumption and emissions by making the aircraft lighter and more aerodynamic. The airline has invested in one of the best flight planning systems available, to carefully plan flights and optimise routes. Emirates prioritise the use of ground power and pre-conditioned air where it is available so that the aircraft's auxiliary power unit can be switched off. All of these measures help to save fuel and emissions. Their flight operations specialists collaborate with air traffic control organisations internationally to deliver more efficient routes and operational procedures, applying the latest in technology to support these enhancements. Their efforts to minimise environmental impact continue onboard the aircraft. The Economy Class blankets on long-haul flights are made from 100 per cent recycled plastic bottles. Cutting down on unnecessary weight also helps us save fuel. Lightweight cargo containers and optimal amount of potable water are used on each flight.

These airlines are just a few examples of the leaders taking the aviation industry towards a more sustainable future. By implementing innovative strategies and prioritising environmental responsibility, they are paving the way for a cleaner and healthier world for generations to come.



Source: Earth.org

ELECTRICITY AND HYDROGEN

Further into the future, there is hope that electric and hydrogen propulsion will answer even the biggest sceptics' objections about the long-term sustainability of the airline industry. Under the Electrified Powertrain Flight Demonstration (EPFD) project, GE Aerospace is teaming with NASA and Boeing to develop an integrated, megawatt-class hybrid electric propulsion system for ground and flight tests later this decade. Pratt & Whitney is developing a hybrid electric GTF demonstrator known as SWITCH (Sustainable Water-Injecting Turbofan Comprising Hybrid Electrics) which could enable up to 25 per cent better efficiency in future short and medium range aircraft. And in February 2022, CFM and Airbus announced a landmark hydrogen demonstration programme under which a hydrogen combustion demonstrator engine could be flight tested within the next few years. However, while electric, hydrogen, and hybrid aircraft could play an increasing part in decarbonising short and medium-haul flights, they are unlikely to be capable of long-haul flights due to their limited flight ranges and the weight of today's batteries. There is also a huge hidden carbon-heavy cost for innovative energy sources – they will demand new planes.

A NOTE OF CAUTION!

The airline industry will face growing headwinds for the next few years as governments and people raise concerns about the climate change impact of air travel. Climate anxiety is increasing even for air travellers. According to a 2022 survey by McKinsey, 56 per cent of passengers surveyed said that they are "really worried" about the industry's climate impacts. Airlines are also coming under increasing pressure over perceived "greenwashing", with activists challenging every claim of climate progress. They term carbon offsetting as "the biggest climate scam." Even the European Union no longer allows offsets to be counted towards emissions reduction targets.

With the 2030 milestone only six years away, SAF remains one of the most promising near-term avenues. However, thereafter, the scale-up of SAF production and usage required to reach the net zero milestone is mind boggling – from just 600 million litres in 2023 to 450 billion litres in 2050. The need of the hour is technology that can produce much more SAF at a much lower cost. Otherwise, sustainability is by no means assured.

The aviation industry itself appears to be banking heavily on SAF to deliver the steep reductions in emissions needed to reach net zero. This is indicated by delayed major product launches, whether for fear of high development costs, or in hopes of achieving future performance improvements. While the RISE programme could be invaluable for Airbus and Boeing to develop new-generation, fuel-efficient, single-aisle aircraft, there is no clear indication that these manufacturers have any such plans. However, even if SAF totally replaces fossil fuels, IATA calculates it would contribute only 65 per cent of the reduction in emissions needed to reach net zero by 2050.

A steely-eyed focus on sustainability is fundamentally altering the way the airline industry operates. But the pace of progress in both SAF and engine enhancement must be greatly accelerated to make net zero a reality. According to Mohamed Ali, GE Aerospace's vice president, "There is no one-fuel or one-technology that will get us to the net-zero goal. It will take new fuels, it will take new engines, and it will take new technologies to get us there." He concludes, "We don't have a day to spare." SP

MANNED-UNMANNED TEAMING: A DIVERSE, DISTRIBUTED TEAM OF CREWED AND UNCREWED SYSTEMS

THE FUTURE OF AERIAL COMBAT

The battle skies of tomorrow will be shaped and decided by pioneering technologies in aerial warfare

By AIR MARSHAL ANIL CHOPRA (RETD)

MILITARY AVIATION AND SPACE HAVE SEEN THE FASTEST evolution. Air power played a significant role in Korea and Vietnam. Arab-Israeli and Indo-Pak wars saw conventional peer-level operations and gave out solid lessons. Iraq and Afghanistan were uncontested battlegrounds. And now Ukraine, Hamas, and Houthis have driven importance of cheaper drones and air defence systems. Clearly aerial technologies and their impact are reshaping the future wars.

The last century has seen aerospace becoming the most preferred means of prosecution of war. The continued need for air and space superiority to allow favourable prosecution of air, surface and sub-surface operations remains underscored. The combat aircraft have become more agile with characteristics of high speed and manoeuvrability, delivered with greater efficiency. Aerial platforms have become stealthier, and support low-observable sensors are able to see and sense farther.

PHOTOGRAPH: LOCKHEED MARTIN

Aircraft can carry and deliver very long-range air-to-air and air-to-surface precision weapons. The aircraft's ability to operate in an intense electronic warfare environment has increased.

Fighter aircraft attributes such as very high speed and manoeuvrability will be less important compared to range and precision of sensors and weapons. Integrated sensors across platforms coupled with secure data-linked communications have allowed the system of systems approach. Artificial Intelligence (AI) supports speedier decision-making.

> The next generation UAS will be able to take on IST, surface strike, air defence, aerial refuelling, and air delivery

NEXT GENERATION FIGHTERS

The next generation aircraft have to be designed for a highly contested and well-defended environment. The combat engagements will be at very long ranges. Platforms that "seeing first, shooting first, and destroying first", and yet are survivability. They will be multiple-role, and carry weapons for both air-to-air and air-to-surface targets. Aircraft should be able to act as mother-ships or controllers in a manned-unmanned teaming mix. Aircraft will be closely integrated and securely data-linked with other platforms in the air or on the surface.

Artificial Intelligence (AI) will support aircrew's cockpit housekeeping chores, and generate weapon firing solutions. "Data-to-decision" (D2D) capability will be crucial. Human-machine interface will improve greatly. All hemisphere situational awareness will allow more comprehensive threat assessments and response options. Futuristic avionics will include agile advanced electronically scanned array (AESA) radars, and passive data-linked sensors. Aero-engines will be flight phase adaptive, more fuel-efficient, and feature thrust-vectoring, and in-built super-cruise. Stealth will be inbuilt in the airframe design through advanced shaping and skin layering techniques using composite materials, without adding weight, or trading in flight performance. Engine inlet and exhaust will be designed for low radar-cross section (RCS) over the entire spectrum of frequencies.

The conformal weapon bays will carry very long-range weapons. Weapons will have increased degree of post-launch autonomy. Enhanced on-board power generation will support powerful electronic warfare systems and DEWs. The aircraft will incorporate preventive maintenance tools, and online health monitoring and diagnostics, with inbuilt structural self-healing materials.

Some technologies may sound weird, such as sweat powered electricity, touch hear text recognition, solar power generating canopies, sub-dermal nutrients, adaptive camouflage or "quantum stealth", magnetic flux generator to fire projectiles (coil guns), self-steering smart guided bullets, among many other technologies.

AERIAL WEAPONS AND SELF-PROTECTION

Future missiles will have long range detection, cruise farther and have high no escape zones. All countries are pushing advanced hypersonic weapon programmes. The US Air Force, along with Raytheon, is working on a mini-missile that can shoot down incoming air-to-air and surface-to-air missiles as part of the Miniature Self-Defence Munition (MSDM) programme.

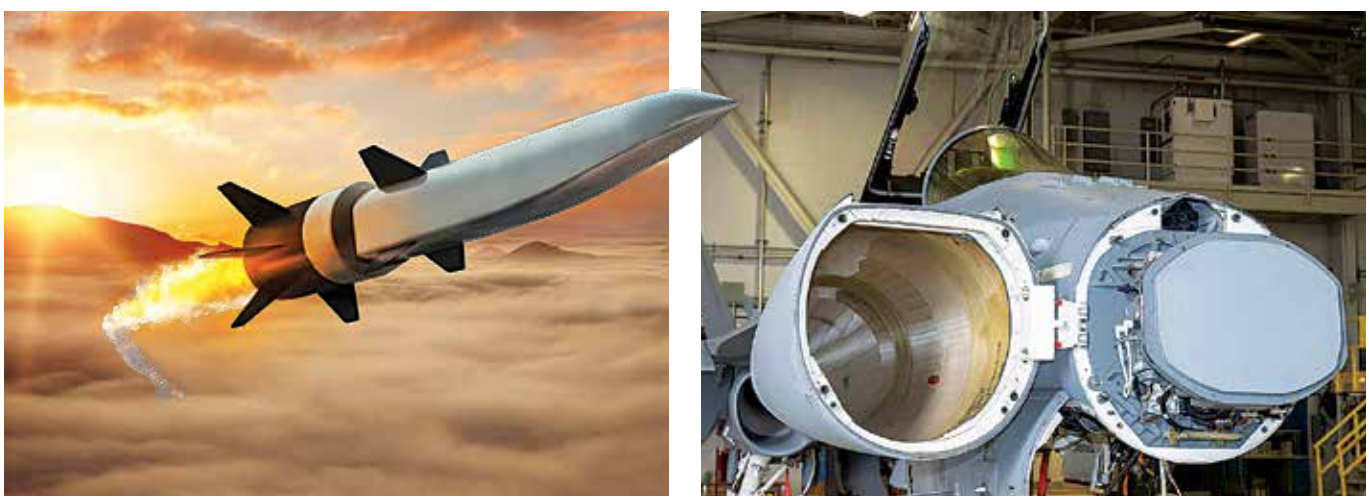
THE MQ-25 WILL BE THE FIRST OPERATIONAL CARRIER-BASED UNMANNED AIRCRAFT AND WILL PROVIDE CRITICAL AERIAL REFUELING AND ISR CAPABILITIES TO SUPPORT THE AIR WING OF THE FUTURE

PHOTOGRAPH: US NAVY / BOEING

New turret systems will allow high-energy lasers to engage enemy aircraft and missiles. Stand-alone high-energy laser weapon pod for being designed. The US Air Force Research Laboratory (AFRL) is developing a fibre laser system called Self-protect High Energy Laser Demonstrator, or SHiELD. It could daze or burn electronics of other airborne platforms. Hypersonic cruise missiles (HCMs) have already been used in combat in Ukraine. Hypersonic Glide Vehicles (HGVs) and HCMs will bring game-changing vulnerabilities to strategic targets and large ships and aircraft carriers. Large platforms like the Airborne Early Warning and Control (AEW&C) and Flight Refuelling Aircraft (FRA) will kept farther away from tactical area by long-range missiles.

India's Astra Mk-1 (110 km) AAM is operational. Mk-2 (160 km) is under development. The very long range (VLRAAM) Mk-3 will have range over 300 km. The air-launched BrahMos missile (500 km) has been integrated on the Su-30 MKI. Longer range variants are evolving. The hypersonic version, BrahMos-II, begin testing in 2024. The later variant will have ranges up to 1,500 km. DEWs are work-in-progress.

Manned and unmanned aircraft teaming (MUM-T) will exploit the advantage of the human in the loop with the strength of numbers to take on well-defended target systems. A large number of Indian companies are engaged in UAV and drone manufacture. Hindustan Aeronautics Limited (HAL) is working on Manned, unmanned teaming (MUM-T).



(LEFT) ARTISTIC RENDERING OF HYPERSONIC AIR-BREATHING WEAPONS CONCEPT (HAWC) MISSILE; (RIGHT) AN/APG-79 AESA RADAR

PHOTOGRAPHS: RTX

UNINHABITED AERIAL SYSTEMS (UAS) AND COUNTERS

Drones and uninhabited systems are already flying in large numbers. Optionally manned aircraft are evolving. Autonomous UAS are operating from aircraft carriers. The next generation UAS will be able to take on IST, surface strike, air defence, aerial refuelling, and air delivery. By the mid-2040s, it is envisaged that every aerial mission could be flown unmanned. Aerial drone swarms have been repeatedly demonstrated, including by Indian manufacturers. Swarms could overwhelm defences by sheer numbers. Drone counters using small arms, electro-optical weapons (laser), data-link jamming, electronic or cyber-attack, are evolving. A drone swarm may be engaged by a counter-drone swarm.

> Future missiles will have long-range detection, cruise farther and have high no escape zones

LARGER VS SMALLER PLATFORMS

Larger platforms have the advantage of longer range and larger quantum of armaments, including very long-range larger missiles. They have the advantage of a greater power source required for DEWs and electronic warfare equipment of the future. Since manoeuvrability will not be crucial for BVR engagements, lack of agility will not be a disadvantage. Large aircraft stealth is already here. Large aircraft will be better suited for MUM-T. Of course, they will be costlier to acquire and maintain. The smaller aircraft have the advantage of being cheaper and agile. A mix of the two types will be required.

LONG ENDURANCE, LONG-RANGE MISSIONS

Humans have to prepare for long-range, long-endurance operational missions that will involve weapon delivery and aerial engagements. Smart drugs and hybrid supplements increase endurance, stamina, physical strength, and alertness levels, and regulate the sleep and waking hours, and pilots could keep awake for days.

AIRBORNE RADARS IN HIGH ECM ENVIRONMENT

Modern AESA radars will require to operate in heavy Electronic Counter-Measures (ECM) environments. In order to reduce the size, weight, power consumption, and cost of AESA radars, small computer-controlled solid-state transmit/receive modules (TRMs) are put together in an array, using

multiple-input multiple-output (MIMO) technology. AESA's beam forming and steering agility will permit better tracking of very fast supersonic cruise missiles and aircraft. AESA radars are also used in missiles for the same reason. To reduce spectrum congestion many applications have moved beyond 20 GHz. Millimetre wave radars can give much better resolution because of ultra wide bandwidths, and lower ground clutter, and they also give the benefit of smaller size. Gallium Nitride (GaN) power transistors can operate at higher power levels and higher frequencies, more efficiently. Future radars will have lower power sectorial emissions and, thus, would be electronically stealthy. India's Uttam AESA radar is evolving well.

PASSIVE SENSORS

Passive systems like the Infra-Red Search and Track (IRST) do not radiate, as such, don't expose own location, and are considered counter-stealth technology. But IR systems are susceptible to weather and atmospheric phenomena. The detection range are currently much lower than radar, at maximum around 100 km. The new concept is to have a universal podded IRST that gives flexibility to match the sensors to the mission quickly. Future high-precision sensors will be more sensitive, use advanced image processing technology and advanced display systems, and pick up weaker signals from farther distances. Dual-band systems are optimised for different ranges. New generation IR detectors are based on Quantum Wall IR Photo-detectors (QWIP) that can sense much less IR energy contrast. Multiple Aperture IR (MAIR) will mean many IR sensors around the aircraft for all-hemisphere detection. It will also act as missile warner.

(LEFT) NORTHROP GRUMMAN TO DEVELOP ADVANCED AIR-TO-AIR MISSILE ENGAGEMENT;
(RIGHT) F-35 GEN-III HELMET MOUNTED DISPLAY SYSTEM (HMDS).

PHOTOGRAPHS: NORTHROP GRUMMAN, COLLINS AEROSPACE

HIGH MISSION TURNAROUND: AIRCRAFT DIAGNOSTICS AND REPAIR

High mission rates are possible through better online aircraft health monitoring. Real-time aircraft systems data is connected to the fleet data bases through Wi-Fi or Satellite communications. The systems are combined sophisticated data processing systems. They incorporate fault diagnostics using AI. Technology will allow predictive maintenance solutions. Online real-time monitoring reduces turn-around maintenance time, and improves aircraft utilisation rate. It could, in the long run, reduce the 'life cycle cost'.

With greater usage of composite, self-healing materials, repairs have become possible and save time. A pocket of epoxy resin and a hardener could be installed near pre-assessed vulnerable parts of the aircraft airframe, and released automatically or manually released to fix the damaged part. Robots will support aircraft inspection and maintenance tasks. Newer systems have redundancies and designed for low meantime between failures (MBTF) to ensure maximum airtime and minimum logistics requirements.

> AI will support aircrew's cockpit housekeeping chores, and generate weapon firing solutions

AIRCRAFT ENGINE TECHNOLOGY

Future engine technologies must support a reduced development cycle, reduce engine weight, improve engine propulsive efficiency and better Specific fuel consumption (SFC), improve reliability and maintainability, and reduce life the cycle costs. New materials will be lighter and withstand higher temperatures. Better turbines machining will also reduce weight and blade balance. The carbon-fibre blades are being used. Full computer controlled "smart engines" and use of magnetic bearings, will also improve engine operations. Additive 3D manufacture will reduce production time and cost. It will also reduce maintenance time. The variable cycle engine will select the high-thrust mode when maximum power is required, and high-efficiency mode during cruise, for fuel savings and best range. New engines will use advanced adaptive versatile engine technology for longer ranges and higher performance. Bio-fuels will be increasingly used. The future will see increased use of electrical power for

aircraft propulsion and various subsystems. Hybrid-electric aircraft are already evolving.

Developing an indigenous aero-engine is a core area for India's 'Atmanirbharta in defence'. DRDO's Gas Turbine Research Establishment (GTRE) has struggled to make a turbojet engine for many decades. There are handful of global manufacturers who do not easily part with technology. Joint ventures (JV) are the best option forward for India. It must exploit large domestic market. Even if it costs money, India must have intellectual property rights (IPR) over the engine. Small engines are also required for cruise missiles and UAVs. India must also invest in electric and hybrid engines.

COMMUNICATIONS AND ELECTRONIC TECHNOLOGIES

5G and 6G telecommunications networks will be crucial for aviation design and on-board data handling. They will also be crucial for satellite and ground-based communications. This will also involve the beaming of millimetre length microwaves at the earth from thousands of new communication satellites. These speeds will also be required for cyber security. Imported electronic hardware of the aircraft could be a high-risk with embedded chips. Indigenisation is very important. Similarly, the electronic warfare equipment has to the home-developed. Microchips are required for aircraft, automation, electro-optical systems, including the weapon sensors. India has decided to invest large sums in their manufacture. 5G will be required for network-centred warfare. Secure, jam-proof data-links will be required for UAS and drone swarms.

MODERN COCKPIT TECHNOLOGIES AND CONCEPTS

Most aircraft already have "glass cockpits." The electronic display screens are reconfigurable. Most traditional controls are being replaced by multifunction "soft keys". "Hands on Throttle and Stick" or HOTAS controls have got refined. Head-Up Displays (HUD), Helmet mounted sighting system and the Direct Voice Input (DVI) reduce the pilot's head-down work. Projections are also being made on cockpit canopies. Virtual retinal displays (VRD) are also evolving.

CRITICAL AIRFRAME TECHNOLOGIES

Composite materials are lighter and stronger are being extensively used in aerial platforms, including in India. Wing body blending is being taken to next level. Flexible aerofoil concepts are evolving. Adaptive-curvature wings will be the future, and will allow changing the wing profile during flight. Actuators and sensors will be used to create computed wing deformations. The wing will not require the traditional control surfaces. Stealth designs will evolve further.

DATA FUSION, ARTIFICIAL INTELLIGENCE AND CYBER SECURITY

The demand for streaming high-quality data requires bandwidth, which involves innovating sensor/processing systems. The data fusion will be deepened by integrating sensors on different platforms, including satellites and drones. Network-centric payload processing units enable on-board data fusion prior to sending to digital links. AI will support aircraft systems management and determine which data should be presented to the pilot. Sensor fusion and optional-manning, would mean heavy reliance on data-links and networks. The sixth-generation avionics will have to be resilient to jamming and have the capability to jam adversary systems.

AUTOMATION SAFETY ISSUES AND MANAGEMENT

Automation in modern cockpits supports many flight assist features. It helps reduced-visibility take-offs, and landings. It also supports multiple systems monitoring, failure alerts, and suggests remedial pilot actions. Automation also assists system health diagnostics. It also relieves pilots from boring repetitive tasks and allows crucial parameter monitoring. The negative fallouts of automation is over dependence and results in declining pilot flying skills. Automatic system disengagement due to a failure state may be missed by the aircrew and have adverse consequences. Unanticipated situations requiring manual override of automation can induce peaks of workload and stress. Automation dependency, inadequate systems knowledge and a lack of manual flying and aircraft management competence could be a deadly cocktail combination, requiring attention.

TECHNOLOGY IMPACT SUMMARY

Robotics and AI will make a huge difference in the times to come. As militaries keep driving technologies, the future will involve more wireless systems. Future warfare will increasingly be through uninhabited systems. Lighter, longer lasting batteries will greatly support automation. Tele-presence will support single-pilot operations, and, along with AI it will keep enhancing decision-making. AI will also support actions to prevent catastrophic events or accidents. 360 degree virtual-reality systems will help improve situational awareness. 6G technologies will make things even faster, which will be crucial for the large volume of data exchange. There will be much improved cloud-based voice "Alexa" type service. Increasing unmanned urban air mobility will seek navigation and traffic safety solutions. Miniaturisation will continue in more areas. Sensors and weapons ranges, and precision will increase further.

Composite materials are lighter and stronger are being extensively used in aerial platforms, including in India

Some of the key technologies will include development and manufacturing of nano-scale, smart meta-materials, and advanced composites. Special coatings will require high-specification machine processes. Some critical minerals will be required for future materials. Platforms will use advanced magnets and superconductors.

Additive manufacturing will grow. AI will influence all aerial technologies, and support hardware accelerators. High performance computing and communications technologies will see more applications. Advanced data analytics and machine learning excellence will evolve. Cyber security will be critical. Advances in hydrogen and other hybrid fuels, and electric batteries will matter. Nuclear energy could one day power aerial platforms. Quantum computing and cryptography applications will evolve. Hypersonic flight and weapons will advance. Drones, swarming and collaborative robots will be used extensively.

India must get into the act, lest it gets left behind! SP

CYBERSPACE IS RECOGNISED AS THE FIFTH DOMAIN OF WARFARE, EQUALLY CRITICAL TO MILITARY OPERATIONS AS LAND, SEA, AIR, AND SPACE. WITHIN THE ASIA PACIFIC REGION, INDIA IS THE SECOND MOST TARGETED NATION FOR CYBERATTACKS.

CYBER LAWS AND REGULATIONS IN INDIA — MILITARY CHALLENGES

The recent attacks on Indian institutions, including the military establishment, call for comprehensive cyber policies which back the many dimensions of national security. In a new scathing report on coordinated cyberattacks on India, researchers have uncovered a new espionage campaign targeting Indian government agencies. What is needed?

By MANISH KUMAR JHA

ILLUSTRATION: SP'S TEAM

IN 2023, INDIA RECEIVED 2,138 WEEKLY CYBERATTACKS PER organisation. Even within the Asia Pacific region, India is the second most targeted nation, trailing only behind Taiwan's 3,050 incidents. There was a 15 per cent surge since 2022 which was again the second highest, following Korea's 21 per cent increase since 2022.

Cyberspace is today recognised as the fifth domain of warfare, equally critical to military operations as land, sea, air, and space.

The defence industry is responsible for developing and maintaining critical military systems, infrastructure, and communication networks. Any breach in such systems can pose devastating consequences for national security. In the world of the military, it is all about security breaches through espionage, sabotage, or theft of sensitive military information. With the advancement in artificial intelligence, IoT, and autonomous systems, the attack surface for cyber threats also expanding in its scope and scale.

According to a recent report, released by The IBM Security Data Breach Report of 2022, the average data breach costs in India have reached a record high of ₹17.5 crores, or around $2.2 million for the fiscal year of 2022. The cyberattacks have increased with a massive surge of 6.6 per cent from 2021, and the cost is turning a staggering 25 per cent increase from the average cost of ₹14 crores in 2020.

Mostly, cybersecurity breaches in India are about unauthorised access to personal and institutional data which leads to the misuse of personal data. Take a look at the recent case of data-theft of Air India, where the data files from more than 4.5 million customers were leaked in a cyber-attack. In a new scathing report on coordinated cyberattacks on India, Researchers have uncovered a new espionage campaign targeting Indian government agencies and the country's energy industry with a modified version of an open-source information stealer called HackBrowserData that can collect browser login credentials, cookies, and history. It was discovered by researchers at Dutch cybersecurity company EclecticIQ in March. While they did not mention specific points of attack, the hackers exfiltrated 8.81 GB of data. In fact, according to the report, the data breach could lead to an attack into the Indian government's infrastructure as per the reports.

> India needs about seven lakh cybersecurity forces, highlighting the urgent need to address cybersecurity skills and workforce development.

Rapidly shifting digital transformation, archaic cybersecurity laws, and the lack of clear, comprehensive data privacy laws, have led the Indian government to begin to reevaluate how it regulates cybersecurity and cybercrime.

CYBER-GAPS

However, the gaps keep surfacing. With such rapidly shifting digital transformation, the complexity poses serious threats across e-governance, e-banking, e-commerce, and private sectors among others. Look at Microsoft's warning for India regarding China's potential use of artificial intelligence to disrupt elections, further targeting national security.

There are areas which focus on specific threats but largely, there are challenges in bringing a comprehensive policy draft. The complexity is so vast that summing up a policy draft on key elements of cyber security — digital intelligence solutions, security solutions for Government and Private enterprises, identity Security solutions, IOT, Industrial networks and Critical Infrastructure and Risk-based management platforms—will be a humongous task. But most importantly, the area to address is cybersecurity skills as India needs about seven lakh such forces.

CYBER LAWS AND REGULATIONS

India has some of most robust regulations and laws beginning with the National Cyber Security Policy (NCSP) 2013. Beginning with the NCSP, the Ministry of Electronics and Information Technology came up with the Information Technology (Guidelines for Intermediaries and Digital Media Ethics Code) Rules 2021. The IT Guidelines replaced IT Rules, 2011 which failed to address emerging areas and threats.

How the policy framework evolved is again based on the emerging threats in the areas. It came upon the challenges posed in addressing data protection led by the Indian Computer Emergency Response Team (CERT-In). Broadly, the CERT-in emerges as a principal guiding force in building a framework for Indian cybersecurity legislation. Moreover, it aims to drive institute data protection policies and protects e-governance, e-banking, e-commerce, and the private sector, among many others.

NATIONAL CYBER SECURITY STRATEGY 2020

The Indian government's eagerly anticipated follow-up plan to strengthen cybersecurity efforts was unveiled in 2020 as the National Cyber Security Strategy. The major objective of the strategy, which is currently being developed and awaiting National Security Council Secretariat assessment, is to act as the official guide for stakeholders, decision-makers, and business executives in preventing cyber incidents, cyberterrorism, and cyberespionage in cyberspace.

THE DIGITAL PERSONAL DATA PROTECTION ACT OF 2023 (DPDP) 2023

Finally, the Government passed its long-awaited Digital Personal Data Protection Act (DPDP). While the act borrows its broad definition of personal data from the EU's General Data Protection Regulation (GDPR), it broadly addresses the key data principles. The DPDP targets the protection of data principals while limiting the activities of data fiduciaries.

WHAT IS REQUIRED?

The crucial aspect here is to continue building a framework as per the widely accepted cybersecurity standards.

The way to address this is to build a comprehensive and informative cybersecurity law in India. The government must continue to work around regulations and reforms to develop a better cybersecurity framework and data protection legislation.

To prevent attacks and limit their spread, a strong authentication process, efficient anomaly-detection systems, and network segmentation should be deployed as the primary lines of defence. Using generative AI, this partnership enhances detection and response capabilities against sophisticated attacks on OT assets for industrial customers, managed security service providers (MSSPs), and managed detection and response (MDR) providers. The collaboration also addresses challenges such as securing OT networks against evolving attacks, while also ensuring smoother deployment and operation.

DEFENCE SPACE AGENCY (DSA)

The DSA will have the responsibility of developing a space warfare strategy and working in close collaboration with the Defence Space Research Agency.

The DSA works under the command of the Integrated Defence Staff and is led by military experts from all three branches of the Indian Armed Forces. As is with other nations, the DSA is an

THE NEED IS TO BUILD A COMPREHENSIVE AND INFORMATIVE CYBERSECURITY LAW IN INDIA. THE GOVERNMENT MUST CONTINUE TO DEVELOP A BETTER CYBERSECURITY FRAMEWORK AND DATA PROTECTION LEGISLATION.

extension of the Indian Air Force and comprises agencies which would deal with the development and operation of various equipment like satellites, radars, missiles, lasers, and other weapons.

The overall aim is to align with several nodes within the military. So, the DSA has a primary Coordination Cell. It is important to mention that the DSA not only collects and coordinates with the Indian Space Research Organisation (ISRO) and the Defence Research and Development Organisation (DRDO), it stands as the leading military agency on space as a domain of warfare. This cell is in close coordination with the Integrated Space Cell which is the nodal agency within the Government of India which oversees the security of its space-based military and civilian hardware systems. In fact, for the same reason, the Defence Imagery Processing and Analysis Centre which is responsible for the acquisition and analysis of the satellite-based images has been merged with the DSA.

Weapons Division. This department of the DSA controls the placing and availability of various missile systems and other weapons like lasers and kinetic bombs across the country on the ground and in outer space. This division can be further subdivided into the following:

- **Ground to Space Section:** This section will be responsible for all missiles, lasers and projectiles being employed from ground stations to target objects in outer space.
- **Space to Space Section:** This section will control all missiles and lasers placed on satellites and launch stations in outer space and will target other objects in space.
- **Space to Ground Section:** This section will be responsible for all missiles, lasers and projectiles being launched from space stations and satellites to target objects on the surface of the Earth.

Radar Division. As and when the space traffic increases, more and more radars and control stations will be required to be established in suitable locations all over the country. The role also extends to monitoring adversaries' assets. Military experts under a committee have recommended another division department for controlling all radar stations and conveying timely and accurate information to all concerned.

Electronic Warfare Division. Focuses on satellite and electronics technology in space and operability. Until now, in terms of military warfare in space, the main objective remains to neutralise the satellite-based surveillance, communications, and positioning systems. It is basically about counter-mechanism to gain tactical advantages. The offensive military tactics are mostly confined and programmed to jam, sabotage, and outright destroy enemy satellites. At the same time, it has a mandate to protect satellites.

INDIA TO AUGMENT SPACE CAPABILITIES

As of now, India has more than a dozen military satellites. The Indian military too employs an assortment of commercial satellites and those run by inviting outside countries in its operations.

It is significant to forcefully make strides in resistance space capabilities as a portion of the "militarisation of space" as India works to decrease guard investing and accomplish self-reliance in the field. This incorporates propelling more satellites into a circle, obtaining superior sensors, high-speed communication, and commonsense and reusable ones, along with the associated framework. Also, India must buy advanced jammers for rebel satellites and protect its shuttle from electronic assaults.

The nation is working to increment its military capabilities in space to attest itself as a strong territorial control in the future. This is because India concentrates on building up self-reliance in guarding, and creating discouragement against China's developing space resources. SP

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ILLUSTRATION: SP'S TEAM

EMBRAER'S C-390 MILLENIUM IS A MULTIPURPOSE AND HIGHLY VERSATILE TACTICAL TRANSPORT JET AIRCRAFT DESIGNED TO SET NEW STANDARDS IN ITS CATEGORY

C-390 MILLENNIUM — EXPANDING FOOTPRINTS

This versatile and cost-effective medium-sized Military Transport Aircraft is making inroads into new markets across borders

By AYUSHEE CHAUDHARY

PHOTOGRAPHS: EMBRAER

BRAZILIAN MANUFACTURER EMBRAER HAS BEEN AMONG THE leading global players in the Aerospace sector. It provides a full line of integrated solutions and applications such as Command and Control Center (C4I), radars, ISR (Intelligence, Surveillance & Reconnaissance) and Space. This also includes integrated systems for information, communications, border monitoring and surveillance as well as aircraft for VIP transportation and special missions. With a growing presence on the global market, Embraer Defense & Security products and solutions are present in more than 60 countries.

Embraer's C-390 Millenium is a tactical transport jet aircraft designed to set new standards in its category. A joint project between FAB (Brazilian Air Force) and Embraer, the multimission jet aircraft features a rugged design that withstands operations from semi-prepared and damaged runways, as well as harsh environments. It is a multipurpose and highly versatile

EXPANDING FOOTPRINT: (CLOCKWISE FROM TOP LEFT) DELIVERY OF C-390 AIRCRAFT TO PORTUGUESE AIR FORCE; EMBRAER C-390 HUNGARIAN AIR FORCE MAIDEN FLIGHT; NETHERLANDS INDUSTRIES FOR DEFENCE AND SECURITY (NIDV) AND EMBRAER HAVE AGREED A MOU SPECIFICALLY RELATED TO C-390 MILLENNIUM; AUSTRIAN MINISTRY OF DEFENSE SELECTS THE C-390 MILLENNIUM AS ITS NEW MILITARY TRANSPORT AIRCRAFT.

aircraft designed to perform various missions, including cargo and troop transport, medical evacuation, search and rescue, aerial refuelling, firefighting, and humanitarian assistance. The aircraft is also capable of operating in harsh environments, such as high altitudes and hot climates. In October, 2023, the Embraer C-390 Millennium achieved another milestone of ten thousand flight hours with the FAB in just four years.

BRAZILIAN AIR FORCE ORDERS

The Brazilian Air Force (FAB) has been the primary operator and supporter of the Embraer C-390 Millennium. The aircraft has been well-received by the FAB due to its exceptional performance and capabilities. The C-390 has enabled the FAB to enhance its transport and logistics capabilities, supporting various missions, including humanitarian operations and military exercises. In April, 2023, Embraer's C-390 Millennium achieved Full Operational Capability (FOC) Certificate, issued by Brazil's Institute of Industrial Development and Coordination (IFI). In June, 2023, Embraer delivered the sixth C-390 multi-mission aircraft to the FAB in FOC configuration, enabling it to fulfill designated missions.

> Embraer Defense & Security products and solutions are present in more than 60 countries, indicating its growing presence on the global market

INTERNATIONAL EXPORT ORDERS

Embraer has been actively marketing the C-390 to potential export customers and several countries have expressed interest in acquiring the aircraft. The aircraft has already been ordered by three countries: Portugal, Hungary, and the Netherlands. Order and talks are also on the table with Austria, Czech Republic, South Korea and Saudi Arabia along with building the Indian Air Force's fleet. Renowned for its multi-mission capability, reliability, and interoperability, the C-390 is redefining military airlift and setting new standards for future generation platforms.

PORTUGUESE AIR FORCE (FAP)

The Portuguese Air Force's (FAP) decision to acquire five C-390 Millennium aircraft in 2019 marked a significant leap in their modernisation efforts. The €827 million contract not only included the state-of-the-art aircraft but also a high-fidelity flight simulator to enhance pilot

training. The first C-390 was delivered to the FAP on October 16, 2022, showcasing the aircraft's cutting-edge capabilities. The remaining four aircraft are scheduled for delivery by February 2027, solidifying the FAP's commitment to advancing its airlift capabilities. With the C-390s entering service, the FAP is phasing out its aging fleet of Lockheed Martin C-130 Hercules aircraft, which have faithfully served the country since the 1960s.

The FAP is eagerly anticipating the operational use of the C-390s, set to commence in early 2023, and has designated Beja Air Base in southern Portugal as the home base for these modern aircraft. On October 19, 2023, the first KC-390 Millennium aircraft of the Portuguese Air Force (FAP) officially entered into service. This achievement followed an extensive flight tests campaign conducted in Portugal through collaboration between Embraer, OGMA, and FAP. Portugal's involvement in the C-390 programme has had a positive economic impact, generating jobs, investments, exports, and technological advancements.

HUNGARIAN AIR FORCE (HAF)

The Hungarian Air Force (HAF) embarked on a strategic modernisation plan with its acquisition of two C-390 Millennium aircraft in 2020. Valued at €254 million, the contract includes the advanced aircraft and a flight simulator to enhance the training process. The first C-390 is scheduled for delivery in 2023, with the second aircraft to follow in 2024. This acquisition signals a pivotal moment for the HAF, as it seeks to replace its aging fleet of Soviet-era Antonov An-26 aircraft, which have been in service since the 1970s and are reaching the end of their operational life.

The C-390s represent a substantial upgrade to the HAF's airlift capabilities, boasting a maximum payload capacity of up to 26 tonnes and a ferry range of around 3,370 nautical miles. These capabilities make the aircraft well-suited for a diverse array of missions, including troop transport, cargo delivery, medical evacuation, and humanitarian assistance. Furthermore, the HAF's participation in international operations will be significantly bolstered by the advanced capabilities of the C-390s, further showcasing the aircraft's strategic importance in bolstering national and international security efforts.

ROYAL NETHERLANDS AIR FORCE (RNLAF)

The Royal Netherlands Air Force (RNLAF) also signed a contract for five C-390 Millennium aircraft in June 2021. Valued at an undisclosed amount, the acquisition represents a crucial step in modernising the RNLAF's fleet. The C-390s, scheduled for delivery between 2024 and 2025, will replace the RNLAF's aging fleet of Lockheed Martin C-130 Hercules aircraft, which have been the backbone of the force's strategic airlift operations.

The C-390 Millennium's adaptability and performance capabilities position it as a versatile asset for the RNLAF. The RNLAF recognises the aircraft's potential in meeting the evolving operational demands of the 21st century. The RNLAF is also considering the potential for additional C-390 acquisitions in the future, with decisions based on their evolving operational requirements and long-term strategic objectives. Contributions from the Dutch ecosystem to the supply chain of the Embraer C-390 programme for export markets will remain a central goal.

AUSTRIAN MINISTRY OF DEFENCE

In a significant move that underscores Austria's commitment to modernising its tactical transport capabilities, the Austrian Ministry of defence announced its decision to adopt the C-390 Millennium aircraft as its new military transport solution. This strategic selection marks a pivotal moment for Austria's Air Force and positions Embraer as a valued partner in enhancing European defence capabilities. Austria is expected to replace its aging C-130 Hercules fleet with Embraer's C-390 military transport aircraft reflecting a strategic vision for enhancing operational capabilities; acquire approximately four aircraft and also explore negotiations with the Netherlands regarding a potential joint order.

INCREASING GLOBAL PRESENCE: (TOP) THE CZECH REPUBLIC AIMS TO PROCURE TWO C-390 AIRCRAFT MILLENNIUM; (ABOVE) SOUTH KOREA SELECTED EMBRAER'S C-390 MILLENNIUM AS THE WINNER OF THE LARGE TRANSPORT AIRCRAFT (LTA) II PUBLIC TENDER.

MINISTRY OF DEFENCE AND ARMED FORCES OF THE CZECH REPUBLIC

In October 2023, the Ministry of Defence and Armed Forces of the Czech Republic announced the start of negotiations on potential acquisition of the new-generation multi-mission Embraer C-390 Millennium. The Czech Republic aims to procure two C-390 aircraft, a move that promises to bolster its airlift capacity significantly. With these aircraft, the Czech Army will enhance its ability to execute a wide array of missions, including air transport, air assault operations, aerial resupply, medical evacuation, humanitarian aid, air-to-air refueling, and firefighting.

Negotiations are underway with the objective of finalising an acquisition contract for the two aircraft, along with comprehensive support services. This support package encompasses a complete training solution for pilots, loadmasters, and technicians, as well as spare parts provisioning and a robust entry-into-operation plan featuring a dedicated presence of

GROWING INFLUENCE: (TOP) SAMI AND EMBRAER SIGNED A MOU WITH EMPHASIS ON LEVERAGING THE CAPABILITIES OF THE C-390 MILLENNIUM; (ABOVE) EMBRAER AND MAHINDRA GROUP INKED A MOU AIMED AT JOINTLY ACQUIRING THE C-390 MILLENNIUM FOR THE INDIAN AIR FORCE.

Embraer personnel in the country during the initial phase. The Czech Republic's active involvement in the development and production of the C-390 Millennium underscores its commitment to fostering collaboration with local industries.

SOUTH KOREA'S DEFENSE ACQUISITION PROGRAM ADMINISTRATION (DAPA)

South Korea's Defense Acquisition Program Administration (DAPA) also selected Embraer's C-390 Millennium as the winner of the Large Transport Aircraft (LTA) II public tender, marking a significant milestone in the aircraft's journey into Asia. The Republic of Korea Air Force (ROKAF) will benefit from this cutting-edge military transport aircraft, marking South Korea as the C-390 Millennium's first customer in the region.

Under the signed contract, Embraer will deliver a customised fleet of C-390 Millennium aircraft tailored to meet the specific requirements of the ROKAF. Additionally, the contract includes a comprehensive range of services and support, encompassing training, ground support equipment, and spare parts. Embraer will facilitate a comprehensive consortium and offset package, involving the production of a substantial portion of C-390 Millennium parts by local Korean companies. Furthermore, the agreement entails the development of a local Maintenance Repair and Overhaul (MRO) provider, enhancing South Korea's aerospace capabilities.

SAUDI ARABIAN MILITARY INDUSTRIES (SAMI)

In a significant development for the aerospace industry, SAMI (Saudi Arabian Military Industries) and Embraer joined forces by signing a Memorandum of Understanding (MoU) in November 2023. The partnership between SAMI and Embraer is poised to expand their operational presence within the Kingdom of Saudi Arabia, with a specific emphasis on leveraging the advanced capabilities of the C-390 Millennium aircraft. SAMI and Embraer will explore the creation of a Regional MRO Hub and a final assembly line for the Embraer C-390, along with the integration of mission systems, all to be based in Saudi Arabia.

By expanding their business scope and capabilities, SAMI underscored its dedication to advancing the aerospace industry in alignment with Saudi Vision 2030. This initiative is integral to SAMI's broader efforts to support the Kingdom's goal of localising 50 per cent of defence spending by 2030, contributing significantly to enhancing self-sufficiency in the defence sector.

INDIAN AIR FORCE (IAF)

Earlier this year, Embraer Defense & Security and the Mahindra Group inked a MoU aimed at jointly acquiring the C-390 Millennium multi-mission aircraft for the Indian Air Force's (IAF) medium transport aircraft (MTA) procurement project. The collaboration between Embraer and Mahindra signifies a concerted effort to harness the unmatched mobility, high productivity, and operational flexibility of the C-390 Millennium, all at a low operating cost, making it an ideal choice for a myriad of missions.

Leveraging Embraer's expertise and Mahindra's local knowledge, they will collaborate with the IAF and the indigenous aerospace industry to devise an industrialisation plan tailored to India's unique requirements. Embraer is actively pursuing avenues for technology transfer in India, engaging with both private enterprises and the IAF to customise their offerings. With the IAF's demand for MTA, Embraer is keen on establishing an assembly line for the C-390 Millennium within India. The long-term vision includes forging strategic alliances and establishing assembly lines and MRO facilities, solidifying India's position as a regional hub for the C-390 aircraft.

FUTURE EXPORT POSSIBILITIES

Embraer is confident that the C-390 will be a successful export aircraft and is already in talks with more countries for export of the aircraft. The aircraft offers a number of advantages over its competitors, including:

- Lower operating costs
- Greater payload capacity
- Longer range
- More advanced avionics

Also, Embraer is committed to providing excellent customer support. The company has a network of service centres located around the world. The C-390 is a versatile and capable aircraft that is well-suited for a variety of military missions. The aircraft is also relatively affordable, which makes it a good option for countries with limited budgets. The Embraer C-390 Millennium's success in international markets can be attributed to its modern design, versatility, and cost-effectiveness, making it an attractive option for air forces and other government agencies around the world seeking a reliable and high-performance military transport aircraft. The future of the Embraer C-390 looks bright, and the aircraft is well-positioned to compete in the global military transport market. SP

LIGHT COMBAT HELICOPTER (LCH) WILL PLAY A CRUCIAL ROLE IN INDIAN MILITARY'S FUTURE ATTACK HELICOPTER STRATEGY

AUGMENTING THE HELICOPTER FLEET

From Ukraine's frontlines to India's skies, a journey through Helicopter warfare and future strategies

By LT GENERAL P.C. KATOCH (RETD)

MOUNTING HELICOPTER LOSSES, BOTH UKRAINIAN AND Russian, in the Ukraine War has been in the news for some time now. At the same time, it is interesting to note that of the about 11,846 US helicopters deployed in the Vietnam War, US records show that 5,607 helicopter were lost, and overall the US military lost almost 10,000 aircraft, helicopters and UAVs (3,744 aircraft, 5,607 helicopters and 578 UAVs). Data also shows that in addition to the losses of Coalition Forces in Afghanistan, the US lost 10 AH-64 Apache helicopters, 14 UH-60 Black Hawk helicopters, 23 CH-47 Chinook helicopters and one CH-53E Super Stallion helicopter in the war.

Details of helicopter losses in the ongoing war in Ukraine will remain ambiguous primarily because of the US-led Western disinformation campaign. As of March, 21, 2024, Ukraine claims to have destroyed 310 Russian helicopters since the war began, including Kamov Ka-52 and Mil Mi-28N helicopters. However, these claims cannot be verified independently, given the fact that Western propaganda has been inflating Russian losses in all domains. How many helicopters the Ukrainian helicopters has lost is naturally not showing up on Google, META or X because of the US policy. However, given the Russian air superiority, helicopter losses on the Ukrainian should be considerable.

According to the Russian Defence Ministry, since the beginning of the special military operation, Russia has destroyed 592 aircraft, 270 helicopters and 22,932 unmanned aerial vehicles (UAVs) of the Ukrainian Armed Forces, as also 509 anti-aircraft missile systems, 15,827 tanks and other armoured combat vehicles, 1,271 combat vehicles of multiple launch rocket systems, 9,081 field artillery and mortar guns, and 21,274 units of special military vehicles.

PHOTOGRAPH: HALHQBLR / X

One thing is however clear that deployment of helicopters along the frontline in Ukraine has become extremely dangerous, with high certainty of being shot down, given the type of weaponry, including AI-enabled platforms employed by both sides. As a result, helicopters at the frontline are only being used in emergency situations like casualty evacuation.

Above does not imply that helicopters will cease to be used in conflict situations world over. Same is the case with tanks and mechanised forces. For example, $500 Russian drones have been effectively destroying $10,000,000 American Abrams tanks in Ukraine according to the New York Times. The proliferation of AI-enabled drones in the battlefield may lead to rethink about long maneuvers by mechanised forces depending on which side has better AI countermeasures, but generally only the tactics of deploying helicopters, tanks and mechanised forces would need to be modified.

News reports of April 11, 2024, state that Indian Military is engaged in bolstering its attack helicopter capabilities. This is being done through a two-pronged policy; procuring the US-made Apache helicopters, as well as the indigenous Light Combat Helicopters (LCH) 'Prachand', produced by the Hindustan Aeronautics Limited (HAL). According to the media, deliveries of the AH-64E Apache attack helicopters for the Indian Army are set to begin in May 2024 when the initial batch of six Apache helicopters is likely to be delivered.

These six Apache helicopters are a separate deal from the Indian Air Force (IAF) existing fleet of 22 Apache helicopters. prioritising procurement of the indigenously developed LCH 'Prachand' attack helicopters. This is evident from their decision to forgo further Apache procurement and focus on inducting the LCH into service.

The Indian Army's acquisition of Apaches and the combined order of 156 LCHs by both the Army and the IAF would contribute immensely towards modernising the Armed Forces and bolstering India's attack helicopter capabilities; strengthening the nation's military preparedness.

While, the Cabinet Committee on Security (CCS) cleared a proposal for 34 new Advanced Light Helicopter (ALH) Dhruv in March 2024 (25 for the Indian Army and nine for the Indian Coast Guard), the HAL has been working on the 13-tonne Indian Multi Role Helicopter (IMRH) project, which is planned to be a versatile and adaptable helicopter designed to serve a variety of roles within the Indian Armed Forces.

A computer-generated model of the IMRH shows the optimal armament configuration capable of carrying up to 1,500 kg of weapons externally. At least three hard points on each side of the IMRH suggests the ability to carry a dual rack of anti-tank guided missiles ATGMs). The image has also raised speculation that it is also likely to be equipped with pods containing 57mm and 80mm unguided rockets or even a nose-mounted 20mm cannon.

The roles to be performed by the IMRH would include air assault, air attack, anti-submarine operations, anti-surface operations, military transport and VIP transport. The IMRH

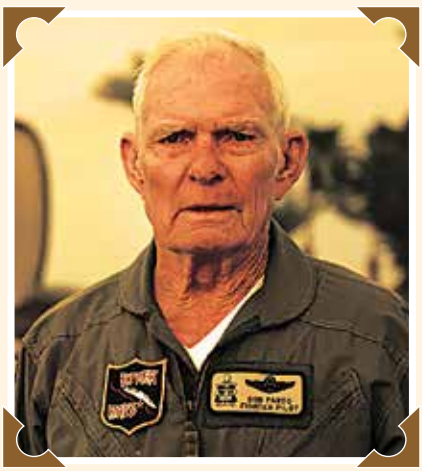
ENHANCING INDIA'S HELICOPTER FLEET:
(LEFT) INDIGENOUS IAF ALH MK-IV; (MIDDLE) IAF'S APACHE HELICOPTER; (RIGHT) INDIAN MULTI ROLE HELICOPTER (IMRH).

PHOTOGRAPHS: IAF_MCC / X, SP GUIDE PUBNS

The news report states that the Army is going in for more Apache helicopters because the IAF has refused to transfer any of its Apache helicopters to the Army although the Army had also contributed funds towards their purchase. Procurement of the six Apache helicopters would boost the Army's attack helicopter capabilities. However, a bigger boost is in the offing with the Army planning to procure an additional 18 Apache attack helicopters, according to the media.

Concurrently, the Army Aviation Corps is also poised to become the primary operator of the indigenous LCH 'Prachand' helicopters. Media states that an order of 90 LCH helicopters is expected for the Army, with an additional 66 planned for the IAF. This huge procurement, estimated to cost over ₹45,000 crore, signifying the crucial role of the LCH in the Indian Military's future attack helicopter strategy. The IAF appears to be is aimed to replace all the current Mi-8 and Mi-17 helicopters of the Indian Armed Forces. The scaled model tests of the IMRH have been ongoing since 2021 while first flight of a full prototype is expected in 2025–26. The introduction into the Armed Forces thereafter is expected in 2028 after two years of testing. A total of six prototypes are planned for trials before production.

IMRH will be the first major project to follow new manufacturing policy under Defence Acquisition Procedure (DAP) 2020. As per this policy, a private sector entity will form a Special Purpose Vehicle (SPV) with HAL for manufacturing the IMRH. With its multi-role functionality and potential offensive capabilities, the IMRH would play a vital role in safeguarding India's airspace. Its development signals a significant step forward for India's defence manufacturing capabilities. SP



BOB PARDO (1934-2023)

In 1989, the USAF reviewed the legendary "Pardo's Push" incident. It belatedly recognised that Bob Pardo had displayed exemplary leadership, airmanship and courage, not to mention creative thinking on that fateful day.

MILITARY AVIATION IS REPLETE WITH STORIES OF MEN AND women who showed amazing heroism in combat. Bob Pardo was one such aviator who, in just 20 minutes in hostile skies, earned a place in the sun.

John Robert Pardo was born on March 10, 1934, in Lacy Lakeview, Texas. Two years after graduating from high school he joined the United States Air Force (USAF). He served combat tours during the Vietnam War in 1966 and 1967. In the course of 132 missions he was awarded the Purple Heart, the Distinguished Flying Cross and the Silver Star.

On March 10, 1967 – his 33rd birthday – Captain Pardo and his weapon system officer, Lieutenant Steve Wayne were flying an F-4 Phantom II. Their target was the only steel production complex in North Vietnam, near Hanoi. Accompanying them in another F-4 were Captain Earl Aman and Lieutenant Bob Houghton. The Hanoi area was one of the most heavily defended in the history of aerial warfare, with perhaps half a dozen surface-to-air missile sites and more than 1,000 anti-aircraft guns. Many US aircraft had been shot down in missions against this elusive target. After several frustrating days when the target had been obscured by low clouds, the sky was clear. During the attack, both jets were hit by ground fire. Aman's plane was badly damaged and fuel began gushing out of a ruptured fuel tank. He realised that he would not have enough fuel to rendezvous with a USAF KC-135 tanker aircraft patrolling over Laos, and hence started climbing prior to ejecting. Ejection over Vietnam meant certain capture with the prospect of being promptly killed or being ill-treated in a prison camp.

Pardo's aircraft seemed only moderately damaged and he could have reached the KC-135 and refuelled before recovering safely at base. However, as he said later, "How can you fly off and leave someone you just fought a battle with? The thought never occurred to me." Soon Aman's jet flamed out and began descending at around 3,000 feet/min. In desperation, Pardo decided to push the stricken aircraft into Laos. This sight is not uncommon on India's roads where a two- or three-wheeler pushes or tows another similar vehicle that has run out of petrol. But this was something else altogether – a military fighter weighing around 15 tonnes and gliding at 250 knots.

Pardo first tried prodding the damaged plane using Aman's drag chute compartment but turbulence interfered. Then he hit upon a brilliant idea. He radioed Aman to lower his tailhook. The heavy-duty tailhook was fitted to enable Naval F-4 pilots to bring the aircraft to a quick stop during a carrier deck landing. Pardo gently manoeuvred his aircraft under Aman's, till Aman's tailhook rested against a bit of metal near Pardo's cockpit canopy. It worked, and Aman's rate of descent soon reduced to 1,500 feet/min. However every 15-30 seconds Aman's tailhook would slip off Pardo's jet. Pardo would then back off a little before cautiously closing in again. If he had been slightly careless or impatient the tailhook would have pierced his canopy glass.

Even as he struggled to assist his comrade, Pardo's aircraft started showing signs of distress. A warning light flashed, indicating that his left engine might be on fire, so it had to be shut down. Pardo tried restarting it, but the temperature gauge went off the clock so he turned it off permanently. In effect, the two jets were now flying under the power of just one out of four engines.

However, although Pardo's aircraft was running out of fuel, he had pushed Aman's jet around 140 km. More importantly, the planes had reached Laotian airspace. There the four aircrew ejected safely at an altitude of 1,800 m. Pursued by some none-too-friendly Laotian villagers they managed to evade capture and were finally rescued by US helicopters. Back at their base in Thailand, Pardo faced the ire of a USAF hierarchy ultrasensitive about combat losses. He was nearly court-martialled for not saving his own aircraft, but was finally let off with a reprimand. Pardo had no regrets saying, "(We) lost eight airplanes that day, but the four of us were the only ones that made it back."

In 1989, the USAF reviewed the legendary "Pardo's Push" incident. It belatedly recognised that Bob Pardo had displayed exemplary leadership, airmanship and courage, not to mention creative thinking on that fateful day. Both he and Wayne received Silver Stars for their heroism in saving their imperilled comrades.

Pardo's loyalty to Aman didn't end there. When he learned that Aman was suffering from Lou Gehrig's disease and had lost his voice and mobility, he created the Earl Aman Foundation which funded a voice synthesiser, a motorised wheelchair, and a computer for Aman. Bob Pardo died on December 5, 2023, in Texas. He was 89. SP

— JOSEPH NORONHA

MILITARY

SIXTH EDITION OF COMMANDANTS' CONCLAVE HELD IN PUNE

The sixth edition of Commandants' Conclave was held at Military Institute of Technology, Pune under the aegis of HQ Integrated Defence Staff on May 7, 2024. The Commandants of esteemed Armed Forces Training Institutions and War Colleges along with other senior leadership of Armed forces attended the Conclave and brainstormed on charting the course for future defence strategies in nurturing the future leaders of Indian Armed Forces.

During the conclave, a wide range of key topics on strategic-resilience, technological advancement, human capital development, interoperability and jointness were discussed to harness innovation, technological advancement and to leverage the best practices of institutions for ensuring world class training at the AFTIs.

BOEING VALIDATES SOFTWARE FOR FUTURE MANNED UNMANNED REFUELING MISSIONS

Boeing has advanced its manned-unmanned teaming (MUM-T) technology using a digital F/A-18 Super Hornet and MQ-25 Stingray. The testing shows the software is maturing for future US Navy use and a potential to deploy the teaming capability on both F/A-18 Block II and III Super Hornets.

In a simulator lab, a Boeing-led team virtually demonstrated an F/A-18 pilot commanding an unmanned MQ-25 to release a refuelling drogue and refuel the Super Hornet, using existing communications links on both platforms.

The new software is a maturation of tests Boeing has previously done. In addition to the upgraded software, test teams pulled in hardware and datalinks already installed on both platforms to run the finalized software further proving Boeing's readiness to deliver this capability to the Navy.

BOEING T-7A RED HAWK TRIPLES PROGRESS

The Boeing T-7A Red Hawk achieved three recent milestones, propelling the advanced pilot trainer for the US Air Force forward.

T-7A aircraft APT-3, one of five engineering and manufacturing development aircraft, underwent rigorous testing at Eglin Air Force Base, enduring temperatures ranging from -25°F to 110°F. Earlier, Boeing and the Air Force conducted a dynamic sled test in February focused on design enhancements in the ejection seat and canopy fracturing system to reduce the risk of injury. Also, Boeing completed development in February of a new software flight control law and since then, has flown the aircraft more than 10 times, reaching 25-degree angle of attack. Additionally, three of those flights demonstrated the aircraft's ability to achieve fine tracking while in high angle of attack, a key capability for pilot training.

While the T-7A Red Hawk continues to progress in testing and flight completions, Boeing is also building a new production line for low-rate initial pro-

APPOINTMENTS

AIR MARSHAL NAGESH KAPOOR TAKES OVER AS AOC-IN-C TRAINING COMMAND

Air Marshal Nagesh Kapoor assumed the appointment of Air Officer Commanding-in-Chief (AOC-in-C) Training Command (TC) on May 1, 2024. He was commissioned into the Fighter stream of the Indian Air Force on December 6, 1986. A Qualified Flying Instructor and a Fighter Combat Leader, he has more than 3400 hours of flying experience. Before assuming the present appointment, he served as the Air Officer-in-Charge Personnel at Air HQ.

AIR MARSHAL S.K. VIDHATE ASSUMED THE APPOINTMENT OF AIR OFFICER IN-CHARGE PERSONNEL (AOP)

Air Marshal S.K. Vidhate assumed the appointment of Air Officer in-Charge Personnel (AOP) on May 1, 2024. Commissioned into the Flying Branch of IAF in June 1987, he has rich experience of flying on various fighter & trainer aircraft of Indian Air Force.

GULFSTREAM PROMOTES ANTHONY NEWLIN TO SENIOR VICE PRESIDENT AND CHIEF INFORMATION OFFICER

Gulfstream Aerospace has appointed Anthony Newlin to the position of Senior Vice President and Chief Information Officer, effective May 31, 2024. With more than 25 years of experience, Newlin joined Gulfstream in 2016 and has focused on developing strategies to increase technology availability and the delivery of innovative solutions to increase mobility and enhance security.

MAGNIX APPOINTS REED MACDONALD AS CHIEF EXECUTIVE OFFICER

magniX, the company powering the electric aviation revolution, today announced on May 6, 2024 that Reed Macdonald has been appointed as Chief Executive Officer (CEO). Macdonald will lead magniX as it readies its revolutionary electric powertrains for entry into service.

duction (LRIP) of the T-7A. The company is slated to load the first forward and aft fuselages for LRIP midyear as suppliers are already underway developing parts for production.

BOEING AWARDED CONTRACT FOR SEVEN MH-139A HELICOPTERS

The US Air Force has awarded Boeing a $178M contract to produce seven MH-139A aircraft and provide sustainment and training support. This order brings the total number of aircraft under contract to 26. The award comes on the heels of the first production aircraft taking its initial flight in December 2023. With the first production aircraft currently undergoing additional testing and other aircraft in various stages of production, Boeing is on track to deliver the first LRIP aircraft to the Air Force this summer.

The MH-139 is a multi-mission helicopter designed for patrol, search and rescue, and troop and cargo transport. Based off the proven Leonardo Helicopters AW139 and fitted with custom military equipment by Boeing, the MH-139 incorporates advanced state-of-the-art technology that allows operators to complete missions quickly, quietly, efficiently and safely.

GA-ASI MOJAVE IN A LIVE-FIRE DEMONSTRATION

General Atomics Aeronautical Systems (GA-ASI) confirmed that its Mojave Unmanned Aircraft System (UAS) destroyed static targets in live-fire tests on April 13, 2024, validating the system's battlefield relevance and recording another milestone for the demonstrator aircraft.

GA-ASI partnered with Dillon Aero to mount two of Dillon's DAP-6 Gun Pod Systems onto the Mojave aircraft. Mojave performed seven passes across two flights during the demonstration, expending around 10,000 rounds of ammunition as the UAS shredded a variety of targets.

Mojave and its short take-off and landing (STOL) capability has built significant interest in the military and aerospace communities. Its ability to take off and land from unimproved landing sites at short distances as well as operate from aircraft carriers is capturing imaginations and changing expectations about how large unmanned systems can be used.

GULFSTREAM G700 EARNS EASA CERTIFICATION

GULFSTREAM AEROSPACE ANNOUNCED the all-new Gulfstream G700 has received European Union Aviation Safety Agency (EASA) type certification, following the aircraft's Federal Aviation Administration (FAA) type certification on March 29.

"The Gulfstream team is proud to add EASA to our growing G700 certification accomplishments," said Mark Burns, president, Gulfstream. "During the flight test programme, we took the G700 across the globe, and the response to the aircraft's cabin size, flexibility and performance has been outstanding. This EASA certification unlocks G700 deliveries for many more of our international customers, and we are excited to see our next-generation fleet grow around the world."

Before FAA certification, Gulfstream announced G700 performance enhancements for range, speed and cabin altitude. The aircraft's range increased to 7,750 nautical miles/14,353 kilometres at Mach 0.85 or 6,650 nm/12,316 km at Mach 0.90, gaining 250 nm/463 km at both speeds over original projections. The G700's maximum operating speed increased from Mach 0.925 to Mach 0.935, making the it the fastest in the Gulfstream fleet. Its cabin altitude, already the lowest in business aviation, was reduced to 2,840 ft/866 m while flying at 41,000 ft/12,497 m, providing even more comfort for passengers.

In addition, the G700's FAA certification confirmed two additional performance improvements, giving customers even more operational flexibility and airport availability: a balanced field length take-off distance of 5,995 ft/1,829 m and a landing distance of 3,150 ft/960 m (standard ISA day, sea level), both shorter than originally announced.

The G700 features the most spacious cabin in business aviation and includes options for a grand suite with expanded lavatory or the industry's largest ultragalley. It can be configured with up to five living areas and features whisper-quiet noise levels, 20 Gulfstream Panoramic Oval Windows and 100 per cent fresh, never recirculated air. SP

CIVIL

BOEING ECODEMONSTRATOR TO TEST TECHNOLOGIES

Boeing is testing three dozen technologies on its ecoDemonstrator programme

focused on strengthening operational efficiency and sustainability in cabin interiors, one of the most challenging parts of recycling an airplane. The company will begin testing this month using a 777-200ER (Extended Range).

The Boeing ecoDemonstrator projects include:

- Airport operations: Testing to enable single-engine taxi and digital taxi clearances to reduce fuel use and enhance safety by reducing pilot workload.
- Airport noise: Quantifying the benefits of flight operation procedures, like steeper glide slope and continuous descent approach, to reduce community noise, fuel use and emissions.
- Waste-reducing materials: Lighter, recyclable and more durable floor coverings and recycled carbon fiber ceiling panels – both made with 25 per cent bio-based resin.
- Noise and weight reduction: Cabin insulation to better reduce noise and regulate humidity and temperature, and fabric-covered acoustic panels for the bulkhead and galley.
- Future cabin concepts: Economy and business class seats with sensors that detect if someone is seated during taxi, takeoff and landing which can improve safety, and reduce crew workload and downtime for maintenance; a touchless water conservation lavatory; and galley technologies to make cabin service more efficient and reduce food waste.

Since its initial flights in 2012, almost every platform of the Boeing ecoDemonstrator programme has flown on sustainable aviation fuel (SAF), and this year, the flagship airplane will fly on a 30/70 blend of SAF and conventional jet fuel.

LOT POLISH AIRLINES TO ADD THREE EMBRAER E195-E2S

LOT Polish Airlines will add the Embraer E195-E2 to their fleet to enhance operational flexibility and accommodate network expansion. LOT will lease three new E195-E2 from Azorra, reaffirming their commitment to sustainable growth with the addition of the 25 per cent more efficient E2 to their fleet. The first jet will arrive by the end of July this year, with all aircraft deliveries completed by October. The new E2s also add flexibility, complementing LOTs larger narrow body aircraft at similar seat costs. LOT has a fleet of 43 E-jets making it one of the largest operators of E-jets in Europe. To date, LOT's E-jet fleet has flown 850 million kilometers, over 1.4m flight hours, and has carried more than 60m passengers – almost twice the population of Poland.

EMBRAER DELIVERS 1800TH E-JET

Embraer has reached a new delivery milestone on the world's preferred small narrowbody aircraft programme; the delivery of the 1800th E-Jet production aircraft. The new Azorra owned E190-E2 was handed over to Royal Jordanian Airlines. This delivery is the third E2 for the airline which currently also operates four first generation E-Jets. RJ will receive a total of eight E2s under the existing deal.

E-Jets have enjoyed global success in the fleets of 90 airlines and leasing companies from more than 60 countries since the first aircraft entered service in 2004. In 20 years of service, the E-Jets have carried two billion passengers on 26 million flights a distance of 140 million kilometres with 90 airlines from 60 countries.

BOEING ANNOUNCES THE WINNERS OF ITS NINTH NATIONAL AEROMODELLING COMPETITION

Boeing announced the winners of the ninth annual Boeing National Aeromodelling Competition, one of India's largest and most popular aeromodelling programs. This year's competition attracted more than 2,350 students from across 855 institutions in the country. This year, the competition also saw an increase in female participation, with 28 per cent of women participating in final rounds.

44 finalists from 13 teams were selected for the finale held in Bengaluru. Meghraj M, Sathvik Poojary, and Sanjana S. from Nitte Mahalinga Adyanthaya Memorial (NMAM) Institute of Technology, Karkala, Udipi District, Karnataka were declared winners of the competition.

The Boeing National Aeromodelling Competition for students across India is conducted in association with IIT Bombay, IIT Kanpur, IIT Kharagpur, IIT Madras, and R.V. College of Engineering. The competition started as an annual event in 2013 to provide a nationwide platform for students who have a keen interest in aerospace engineering and related fields.

ATR ANNOUNCES SALE OF 10 ATR 72-600 TO AVATION

ATR announced the signature of a firm order for 10 ATR 72-600 with Avation PLC. Deliveries are scheduled between 2025 and 2028, showcasing Avation's long-term vision and confidence in the relevance of ATR's products to serve the regional aviation market. The agreement is further complemented by 24 purchase rights, extending until 2034.

This order marks another milestone in the enduring relationship with Avation which began in 2011. Since then, the Singapore-based lessor took delivery of 36 new ATR 72s, with two more scheduled for delivery in the coming months, as part of a previous order. Avation currently owns a fleet of 20 ATRs.

EVE AIR ON JAPAN'S ADVANCED AIR MOBILITY PUBLIC-PRIVATE COMMITTEE

Eve Air Mobility has been named a member of Japan's Advanced Air Mobility (AAM) Public-Private Committee. The committee is responsible to evaluate and make recommendations to the Japanese Ministry of Economy, Trade & Industry and Ministry of Land, Infrastructure, Transport & Tourism on AAM regulations & policies for Japan.

Established in 2018, the committee is made up of selected members discuss the development of various AAM services such as passenger transportation, scenic flights, and air ambulance services throughout Japan. Eve would bring its global perspective and expertise to help contribute to the advancements being made to develop the AAM industry in Japan.

In addition to developing its eVTOL aircraft, Eve will offer its customers access to an existing worldwide network of service centers through its relationship with Embraer, one of the world's largest manufacturers of aircraft. The company is also developing several solutions to support its customers on Day 1 ranging from flight operations solutions and network optimisation to data management and eVTOL health monitoring.

PROMOTE SUSTAINABLE AVIATION

The ambitious goal of decarbonising the aviation sector by 2050 necessitates a comprehensive strategy. Among the array of solutions, the increased adoption of Sustainable Aviation Fuel (SAF) emerges as a pivotal element in mitigating environmental pollution and fostering sustainable growth.

By ROHIT GOEL

THE INDIAN AVIATION SECTOR IS ON A SKYROCKETING JOURNEY, but this growth comes with a hefty environmental price tag. Greenhouse gas emissions are a major concern, and achieving net-zero emissions by 2050 requires a drastic course correction. Sustainable Aviation Fuel (SAF) has emerged as a game-changer, offering a cleaner alternative to traditional jet fuel. However, adopting SAF in India requires navigating a complex landscape of challenges and opportunities.

One of the biggest hurdles is ensuring a steady supply of sustainable feedstock for SAF production. While India has an abundance of potential raw materials, the infrastructure for collecting, segregating, and supplying these materials efficiently is lacking. This needs to be addressed to avoid disruptions in the SAF production chain. Furthermore, ensuring sustainable agricultural practices for feedstock cultivation is crucial. Large-scale cultivation of crops like oil palms, if not managed carefully, can lead to deforestation, water scarcity, and competition with food production. India needs to strike a delicate balance between harnessing its resources and protecting its agricultural future.

Cost is another major barrier. Currently, SAF is significantly more expensive than conventional jet fuel. This acts as a strong disincentive for airlines, who are already operating on tight margins. Large-scale production of SAF is essential to bring down the price. Government support, in the form of subsidies or tax breaks, can play a crucial role in making SAF a more attractive option for airlines.

Policy and regulatory frameworks also need to evolve to support SAF adoption. The current approval process for SAF production is lengthy and cumbersome, hindering the scaling up of production capacity. Streamlining these processes and creating a more supportive regulatory environment is crucial.

Technological advancements offer a glimmer of hope for the future. While battery-powered and hydrogen fuel cell technologies hold immense promise for zero-emission aviation, their current limitations restrict their applicability to shorter routes. However, continued research and development in these areas are essential for the long-term decarbonisation of the aviation sector.

Despite the challenges, India has the potential to become a leader in sustainable aviation. A collaborative effort between the government, aviation industry, and research institutions is essential to overcome these hurdles. India should tailor policies to its unique challenges and requirements and the government can play a pivotal role by developing a comprehensive policy framework that incentivises SAF production, mandates blending SAF with traditional jet fuel, and invests in research and development of clean aviation technologies. Collaboration between various Government Departments and Ministries like the Ministry of Aviation, Ministry of New and Renewable Energy, Ministry of Environment, Forest and Climate Change, and others, is crucial in formulating a comprehensive policy framework for decarbonising the aviation sector. A transparent and predictable policy environment fosters investor confidence and accelerates the transition towards low-carbon aviation. Airlines can contribute by exploring options to share the cost burden of SAF.

Public-private partnerships are another key driver of progress. Encouraging private companies to invest in SAF production through Corporate Social Responsibility (CSR) initiatives can significantly accelerate the development of a robust domestic SAF industry. Also, collaboration with leading countries in sustainable aviation is crucial. By learning from best practices and sharing knowledge, India can expedite its transition towards a low-carbon aviation sector.

The road to a sustainable aviation industry is paved with both challenges and opportunities. Policy implementation with country- and region- specific directives will be core to the acceleration of this process. Efforts should be focused on cost-effective SAF production and scaling up, in addition to the adoption of global best practices in this sector. Seeking more intensive collaborations and strategic partnerships in aviation will lay the foundation for a systemic low-carbon transition.

In India, a collaborative effort, led by the Government, is needed in addressing these issues related to feedstock availability, cost competitiveness, policy frameworks, and technological advancements. Urgent and decisive action on the part of all stakeholders, working towards a common objective of promoting the usage of SAF, can ensure that the aviation sector in India soars towards a cleaner and greener future. This joint effort will not only benefit the environment but also solidify India's position as a global leader in sustainable aviation. SP

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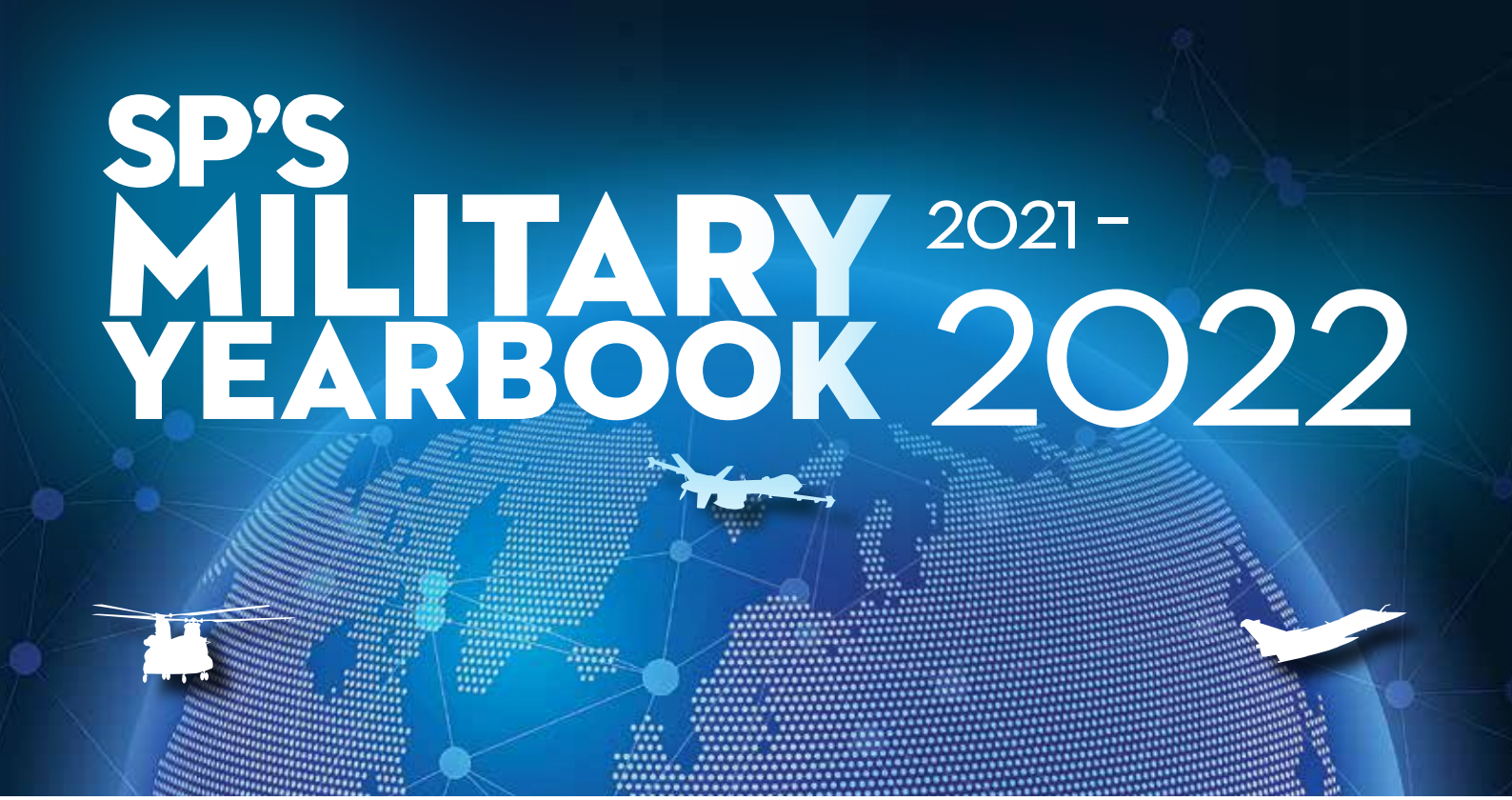

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