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## EDITORIAL

Dear reader,

You are holding a new issue of the Air Era Magazine, a first of its kind Aviation Magazine aimed at acting as a media for all Aviation related activities as well as to enlighten students and Aviation enthusiasts with the latest trends.

It is our endeavor to bring out stories of our own heroes who have contributed to the Indian Aviation as well as the local industries and R & D institutions.

This is a special edition for “Aero India 2017” featuring “Airshows of the world”, a special article by Air commodore Sajjad Rahim. The personality of this issue is Dr. Satish Dhawan, the father of experimental fluid dynamics research in India.

We urge you to support us in our endeavor by following every edition of our magazine and providing us with constant feedback and help us to fill the void of an Indian aviation magazine aimed at the student community and the general aviation enthusiasts.

Joffin Jose  
Editor in-Chief

# ISRO Successfully Tests C25 Cryogenic Upper Stage of GSLV MkIII

Indian Space Research Organisation (ISRO) successfully ground tested its indigenously developed Cryogenic Upper Stage for GSLV MkIII on January 25, 2017. The cryogenic stage designated as C25 was tested for a duration of 50 seconds at ISRO Propulsion Complex (IPRC) in Mahendragiri demonstrating all the stage operations. The performance of the Stage during the test was as predicted. This is the first test in a series of two tests. The next test is planned for flight duration of 640 seconds.

The 50 second test is a significant milestone in the development of indigenous cryogenic propulsion technology. The successful hot test of the stage in the first attempt itself demonstrates ISRO's ability to work in new areas like cryogenic technology.

The development of C25 cryogenic stage began with the approval of GSLV MkIII, the next generation launch vehicle of ISRO, capable of launching 4 ton class spacecraft in Geosynchronous Transfer Orbit (GTO). The vehicle consists of two



C25 D- Stage on Test Stand

solid strap-on motors (S200), one earth storable liquid core stage (L110) and the cryogenic stage upper stage (C25).

The C25 stage was conceptualised, designed and realised by Liquid Propulsion Systems Centre (LPSC), ISRO's lead Centre for Propulsion, with support from

various System Development Agencies from other three Centres of ISRO – Vikram Sarabhai Space Centre (VSSC), ISRO Propulsion Complex (IPRC) and Sathish Dhawan Space Centre (SDSC) SHAR. The fabrication of various sub-systems of the engine and the stage was carried out through Indian Industries.

The C25 stage is the most powerful upper stage developed by ISRO and uses Liquid Oxygen (LOX) and Liquid Hydrogen (LH2) propellant combination. The stage carries 27.8 tons of propellants loaded in two independent tanks.

Development of a cryogenic stage has unique design challenges, with liquid Hydrogen stored at -253 deg C and liquid Oxygen stored at -195 deg C in its tanks. To store these cryogenic fluids, special multi-layer insulation is provided for the tanks and other structures.

The first flight stage for GSLV MkIII-D1 mission is in advanced stage of realisation. The flight engine has been successfully tested in the High Altitude Test (HAT) facility and integrated with the flight stage.

## Nuclear-capable Agni-IV missile successfully test-fired off Odisha coast

A week after test firing Agni-V, India conducted the final test-firing of another nuclear-capable strategic ballistic missile, Agni-IV, from test range off Odisha coast. With a range of more than 4,000 km, the missile was successfully test fired from Balasore. After the launch of Agni-V, the government had to clear out that its strategic capabilities were not targeted

against any particular country as it abides by all applicable international obligations and expects others do the same, in a response to Chinese reaction to the development. The indigenously developed surface-to-surface Agni- IV missile is a two-stage weapon system. It is 20 metres long and weighs 17 tonnes. Agni-IV missile is equipped with 5th generation onboard

computer and distributed architecture. It has the latest features to correct and guide itself for in-flight disturbances. Agni-I, II and III and Prithvi are already in the arsenal of the armed forces, giving them reach of over 3000 kms and providing the country an effective deterrence capability.

Source: <http://indianexpress.com/>

## HAL HAS ROLLED OUT THE FIRST INDIGENOUSLY UPGRADED HAWK

HAL has rolled out the first indigenously upgraded Hawk Mk132, named as Hawk-i on the eve of Republic Day celebrations. "This is the 100th Hawk aircraft produced at HAL and we are proud that it has Make in India mark. HAL had conceived a programme for indigenous upgradation of the Hawk Mk132 for achieving self-reliance and has successfully accomplished it", says Mr. T. Suvarna Raju, CMD, HAL. This aircraft would be on the flying display in the Aero-India 2017 at Bengaluru, he adds.

The upgrade of HAWK Aircraft was taken up at HAL to so as to be independent in matters such as integration of new sub-systems or modifications, obsolescence management of avionics systems and to enhance the aircraft operational and training capabilities. HAL has rolled out its own aircraft with the upgrade features in a record time.

In the Hawk upgradation programme, imported Mission Computer and Data



Transfer Units have been substituted with HAL designed and developed systems. This indigenous Mission Computer in the dual redundant configuration has additional capabilities such as Digital Map Generation (DMG) which provides improved situational awareness. The Embedded Virtual Training System (EVTS)

offers improved training capability over the existing system. The HAWK-i also provides secured voice communication and data link capability by integration of Softnet Radio and pilots can configure and select cockpit Human Machine Interface (HMI) for different aircraft platforms.

## SOLAR IMPULSE FOUNDER SEES ELECTRIC PASSENGER PLANE IN 10 YEARS

The co-founder of a project that saw a solar-powered aircraft complete the first fuel-free flight around the world this year expects electric passenger planes to operate in just under 10 years. Bertrand Piccard, who along with fellow pilot Mr. Andre Borschberg founded Solar Impulse, also shrugged off concerns that U.S. President Donald Trump's appointment of a fossil fuel industry defender as his top environmental official could hamper global clean technology efforts. Since completing their historic fuel-free flight in July, Mr. Piccard and Mr. Borschberg have

been working on projects to show how the technologies used in their plane can be used in other applications. Mr. Borschberg said they were especially interested in how the technology could be used to develop small electric planes with a flying time of about 1.5 hours. The two plan to announce their next project early next year, Mr. Borschberg said. "In 9 years and 8 months, you'll have 50 people traveling short-haul on electric planes," Mr. Piccard, founder and chairman of Solar

Impulse told an IATA airlines association briefing in Geneva. "Why 9 years and eight

months? Because since four months, I've been saying it will be '10 years'. It will happen," he added. Mr. Piccard said that it didn't matter what people thought about climate change because clean technology was getting cheaper and would help to drive growth. He cited examples of insulation making homes cheaper to live in, of LED lights reducing lighting costs. "Five years ago everything that was clean tech was more expensive - that is not the case today. If the aim is to be profitable and create jobs, then coal is out of business," he said.

# SEAPLANE TO LAKSHADWEEP LIKELY TO TAKE OFF IN TWO MONTHS

**P**private firm to launch operation in the Kochi-Lakshadweep route. The long-awaited seaplane operations are expected to commence within two months. The preparations undertaken by a private operator for flying to Lakshadweep are in final stages. The operator had been waiting for DGCA certifications and clearances. The procedures were in final stage, a top representative of the Kerala-based company told. "It is hoped that the service could be started by January end or February," he said.

## Another aircraft soon

The company, Seabird Seaplane Private Limited, had flown in a brand new amphibious aircraft, a Quest Kodiak 100, with a seating capacity of 10 persons including pilot, from the U.S. in October 2015. Eight seats will be available for passengers. One more aircraft is being added to the fleet. The company plans to commence operations in the Kochi-Lakshadweep route which has a high tourist traffic. The flights will be of 1 hour and 35 minutes duration. The flight will land at Kavaratti and Minicoy.

## Other destinations

Other destinations planned by the operator are Bengaluru, Bekal, Kadavu, Kumarakom, Kollam, and Thiruvananthapuram. The flights can land either on waterbodies or at airports

and airstrips. Landing on water has been planned at Kumarakom and Kollam. Kadavu is on the banks of the Chaliyar river in Malabar. Apart from carrying tourists, the flights could be chartered or utilised for evacuation purposes in times of emergency, company sources said. Alappuzha, one of the initial itineraries selected by the government, has not been included in the initial stage as the waterdrome has not been built there. The original plan to build the waterdrome at Punnamada was opposed by fishermen and the location was shifted to Vattakkayal, a few kilometers away. The equipment required to set up the waterdrome had been transported to the location, but subsequent works were not executed.

The State government had officially launched the seaplane operations at Kollam in June 2013, but the move to arrange regular flights from Kollam to Alappuzha was opposed by fishermen's organisations on the ground that the flight landings on waterbodies would affect fishing, the means of livelihood of a number of people. The government had constituted an expert committee to study the issue. The panel had recommended shifting of the waterdrome from Punnamada to Vattakayal. It had drawn the government's attention to the need for a package for fishermen.

Source: <http://www.thehindu.com/>

# Boeing expands Bengaluru Technology Centre

**B**oeing's technology centre here plans to roughly double its headcount of engineers to 800 by the year-end. It will further expand its engineering strength to around 1,000 in about two years, a Boeing spokesperson said, citing senior company officials, who were in the city. Recruitments for the India centre have scaled up in the last 18 months, they said at the newly launched bigger location of the Boeing India Engineering & Technology Centre (BIETC).

The Bengaluru centre is one of the six such outside the U.S. Currently the centre employs around 350 engineers to support Boeing's global activities in information technology and data analytics, engineering, test and research and technology, enhancing "Boeing's ability to deliver cutting edge aerospace innovation," a company release said.

Most of them fall under the offsets clause tied to the purchase of military and civil aircraft from Boeing. Greg Hyslop, Boeing chief technology officer and senior vice-president, Boeing Engineering, Test & Technology, and Mr Pratyush Kumar, president for Boeing India, were at the new centre. BIETC will support the development of advanced environment friendly coatings, data analytics for next generation airplane health management tools, besides software tools for airlines and airports.

Source: <http://www.thehindu.com/>



# BABY BOOM

## New Entrant to the Neo modern Space Era

Talla Srikanth

After the dismissal of the Concorde in 2003, there has been elusive dream of aerospace manufacturers to bring back the supersonic air travel. The Concorde could not be retained due to variety of reasons: expensive tickets, sonic booms that nixed overland travel, the slowdown in air travel after Sept. 11. It's been fourteen years and we haven't seen a viable supersonic passenger jet since.

Finally a Denver startup called Boom technology, an aerospace company out of Colorado, just revealed the engineering design information for their XB-1 demonstrator aircraft—a

two-seater supersonic jet that will serve as a one-third scale test aircraft to ultimately develop a 45 person passenger aircraft capable of achieving a cruise speed of Mach 2.2, or 1,450 mph by the end of 2017. Boom also isn't the first company to make this promise. Multiple startups including Aerion have recently brought supersonic prototypes to the market, though none have officially launched a commercial product except Boom.

Blake Scholl, founder & CEO of boom, is a pilot and technology entrepreneur. He previously

built marketing automation at Amazon and founded mobile technology startup Kima Labs.

Boom has 11 people working out of Centennial Airport just south of Denver. Chief engineer and co-founder Joe Wilding has designed passenger planes for three different aerospace companies. Andy Berryann, chief of propulsion, was an engineer at Pratt & Whitney who helped build the engines for the F-22 Raptor and F-35 Joint Strike Fighter. Principal Aerodynamics Engineer Kenrick Waithe worked for NASA and Gulfstream Aerospace on the



Quiet Boom project to study the suppression of sonic booms. The rest of the team includes aerospace engineers and propulsion experts from Lockheed Martin, Boeing, and Northrop Grumman subsidiary, Scaled Composites.

In addition to a stellar team of engineers, Boom Technology has Richard Branson's Virgin Group backing them with both funding and engineering support. The Spaceship Company, a subsidiary of Virgin Galactic that has been leading development of next-generation aircraft for commercial use. As part of its partnership, The Spaceship Company will provide engineering, design and manufacturing services, flight tests and operations.

The XB-1 is nicknamed as "Baby Boom". It is 10 percent faster than the Concorde's speed of Mach 2. It's also 2.6-times faster than the average commercial airliner. The XB-1 frame will incorporate lightweight, heat-resistant composite materials that Boom is planning to use on the full-scale aircraft as well. The chine fuselage and delta-wing design will allow the XB-1 and the ultimate passenger plane to achieve supersonic speeds without the need for afterburning turbofans, resulting in more efficient flight. Concept of tri-jet helps lower takeoff



noise. Additionally, three-engine aircraft are treated as more reliable by FAA regulations; ETOPS rules permit new three-engine aircraft to fly more direct overwater routes than twins, leading to faster flight times

If Boom can pull it off, a flight from New York to London on one of their planes would take only 3hrs 15 min with a cruising altitude of 60,000feet where passengers will be able to see the curvature of the earth right through the window. Boom CEO Blake Scholl is targeting round-trip ticket prices of \$5,000 in this sector, which are competitive with today's fares operated on conventional Airliner. And perhaps because of

those aggressive forecasts, Virgin Atlantic has already committed to take the first 10 of Boom's aircraft.

### Onboard Experience

Its 40 seats will be split into two single-seat rows, so everybody has a large personal window, direct aisle access, and a dedicated overhead bin. Seat dimensions will be similar to short-haul first class, with many subtle and not-so-subtle design improvements. On flights over 6 hours (i.e., those over 15 hours today), airlines may offer a first-class lay-flat suite experience.

The viability of supersonic flight depends entirely on the ability to reduce operating costs sufficiently and also achieve good load factors and strong margins.

Today, passengers pay a 4-5X premium for business class, even though those seats don't arrive any sooner than economy. Passengers today pay a premium for non-stop (vs. connecting) service, so it is reasonable to expect higher fares for still faster service. The advantage of 2.6X faster flight will also allow them to win competitors most profitable premium passengers. Moreover, there are cost savings associated with





supersonic flight: saved executive time, saved hotel expenses, and saved meals and entertainment expenses.

Thus a supersonic passenger flight is surely an inevitable future.

It is compatible with existing ground support equipment, gates, and runways. At maximum take-off weight, an 8,500' runway is required (sea level, standard day). This allows Boom jets to operate out of all major international airports.

### SPECIFICATIONS

When the XB-1 takes to the skies, it will be the first independently-developed and privately-funded supersonic aircraft ever built.

Boom says it plans to initially fly from London to New York, San Francisco to Tokyo and Los Angeles to Sydney.

#### Design Specifications: XB-1 Supersonic Demonstrator

- Crew: Two (pilot + optional flight test engineer or passenger)
- Length: 68', Wingspan: 17'
- Maximum Takeoff Weight: 13,500 lb

- Powerplant: 3X General Electric J85-21, non-afterburning; proprietary variable-geometry intake and exhaust
- Aerodynamics: Chine, refined delta wing with swept trailing edge
- Cruise: Mach 2.2 (1,451mph, 2,335 km/h)
- Nose Temperature: 307°F (345°F on ISA+20 day)
- Range: > 1,000nmi

#### Design Specifications: Boom Passenger Airliner

- Crew: Two
- Length: 170', Wingspan: 60'
- Passengers: 45 standard (up to 55 in high density)
- Flight attendants: Up to 4
- Lavatories: 2

- Powerplant: 3X non-afterburning medium bypass turbofan; proprietary variable geometry intake and exhaust
- Aerodynamics: Chine, refined delta wing with swept trailing edge
- Long Range Cruise: Mach 2.2 (1,451mph, 2,335 km/h)
- Nose Temperature: 307°F (345°F on ISA+20 day)
- Maximum Design Route: 9,000nm (4,500nm unrefueled)

It's finally time for the aerospace industry to put together an affordable supersonic airliner with the available technology which boasts a combination of advanced aerodynamics, efficient engine technology and new composite materials. We can't wait it see the first flight of baby boom that will take place in the second half of this year 2017.

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# PROF. SATISH DHAWAN

## THE DOYEN OF INDIAN AEROSPACE COMMUNITY



It has been a decade and a half since Professor Satish Dhawan, the former Chairman of Space commission passed away. But his legacy continues. He was the true doyen of Indian aerospace community and his name still inspires many.

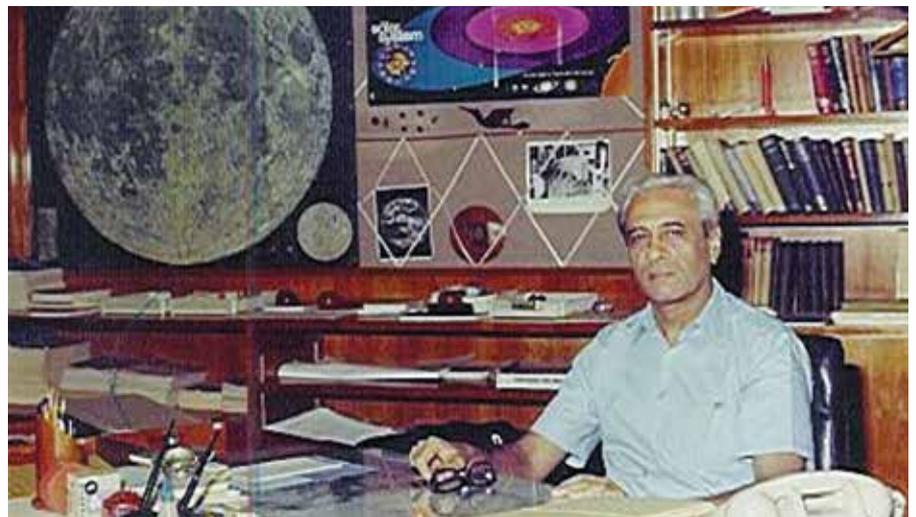
Professor Satish Dhawan was a multi-faceted person. For his students at the Indian Institute of Science (IISc), Bengaluru, he was a great teacher and the young Director who mesmerized them and transformed the institute. For the space community, he was the architect who transformed the vision of Vikram Sarabhai into a national mission, which has put Indian Space Research firmly in the international space map. The Mars mission of Indian Space Research Organisation (ISRO) which was accomplished in a cost effective manner is the hall mark of Prof.Dhawan's vision – a technology that is native and cost effective. To quote Prof.R.Narasimha, his student, distinguished Scientist, former Director of National Institute of Advanced

Studies (NIAS) and CSIR-National Aerospace Laboratories(CSIR-NAL), Bengaluru, “He was the father of Experimental fluid dynamics research in India. He was the undeclared but widely accepted moral and social conscience of the scientific community.”

Prof.Dhawan was my teachers' teacher, the Pitamaha. As a student of the Dept. of Aeronautical Engineering at IISc during 1971-73, I first met him in 1972. As he returned from his sabbatical to

take over as the Head of Indian Space program, he made it a point to meet all the students of his department in a get together at the Institute Gymkhana. I still remember, Prof.Dhawan going around and talking to each one of us. It was a privilege and honor for us, that the director of the institute met us.

During my career at the CSIR-NAL, Bengaluru from 1973-2005, he was our guiding spirit as the Chairman of the Research council. He had great



concern about the development of our laboratories into a premier aerospace research laboratory. He was instrumental in CSIR-NAL taking up civil aircraft design and development activity through Hansa and SARAS programs.

Many distinguished people who were associated with Prof.Dhawan have written glorious tributes to him. Here, is an attempt to put these together and bring out the multi-dimensional personality of this great teacher and visionary.

Prof.Dhawan was born on 25th September 1920 in Srinagar. He graduated from the University of Punjab (Lahore) with BA in Mathematics and Physics, MA in English Literature, and a BE in Mechanical Engineering. After spending a year at Hindustan Aeronautics Limited (HAL), he went to USA on a government scholarship. In 1947, he obtained an M.S. in Aeronautical Engineering from the University of Minnesota and moved to California Institute of Technology (Caltech.) where he was awarded the Aeronautical Engineer's Degree in 1949 and a PhD in Aeronautics and Mathematics in 1951 with the eminent aerospace scientist and fluid dynamicist Hans W. Liepmann as adviser. His pioneering research work included his studies of shock waves as they hit a flat plate, work which was important for supersonic flight.

As Prof.R.Narasimha, puts it –“ At Caltech he made an extraordinary impression, and left a glow of fond memories behind him when he left to return home in 1951-for here was an Indian who was not only ingenious at hooking up new and intriguing experiments but could also play with hypergeometric functions, quote Shakespeare for every occasion, and regale his friends with stories about the



camel answering to the name of Greta Garbo in the Khyber Pass (Prof.Satish Dhawan grew up as a young man in what is now Pakistan).

This educational breadth, covering science, engineering and the humanities, and his distinguished family background, appear to have given Dhawan an ability to view the world from many different angles, and may explain in part his unique qualities as a leader”[1].

Prof.R.Narasimha, recalls Prof. Dhawan, the teacher as follows: “I recall a tall, handsome, young man who would jump out of his sporty little MG car, wearing a red shirt and a broad smile, racing across the staircase in the Department and cheerfully saying ‘Good morning’ as he stepped into the class room. Dhawan brought to the Institute an element of youth, freshness, modernity, earnestness and Californian informality that captivated the students and many colleagues. In short, he was a star on the campus.

Students liked his classes very much indeed, and for a variety of reasons; His lectures were advanced, simple and elegant at the same time, and quickly gave students a sense of confidence. He took his teaching very seriously, and supplied his classes with plenty of notes, data sheets, diagrams and so

on. He worked hard on all these – one would often see him in his office late at night – and he expected the students to work just as hard – which many of them cheerfully did. Another reason for the great popularity of his classes – last but not least, as they say! – was that he was generous with his grades if the student had got the gist of what had been taught in the classroom.”

Dr.APJ Abdul Kalam, former President of India, was closely associated with Prof.Dhawan in the Satellite Launch Vehicle(SLV) program of ISRO. Dr.Kalam in his tribute to Prof. Dhawan [2], recalls his earliest association with him in connection with the design of contra rotating propellers for the Hovercraft “Nandi” developed at Aeronautical Development Establishment(ADE). When approached for guidance on the design of Contra-rotating propellers, Prof.Dhawan agreed and gave ten exclusive lectures. Later, he not only reviewed the design, but also took him through fabrication and testing of these propellers. Dr.Kalam calls Prof. Dhawan a creative teacher – as his teaching created a spirit of research and enquiry in him, taught him design without giving him the design!

About Prof.Dhawan’s research, Prof.R.Narasimha says [1] – “At the



Prof. Dhawan was the director of IISc from 1962 to 1981. In Prof. R. Narasimha's words – "His was the longest in the Institute's history for any director. Over this period Dhawan was able to exert a long-lasting influence on the Institute's intellectual character, its programmes in both research and education, and its administrative structure. The period was also marked by an extraordinary expansion in the diversity of the research programmes, as a large number of new faculty joined at various times and a variety of new centres were set up. When Prof. Dhawan took over the Institute it was relatively small: there were only 11 departments and 5 sections. By the time Prof. Dhawan left there were some 40 Departments and Units in the Institute. The Institute has continued to grow and flourish under successive directors after Dhawan and there have been many new programmes as well. But I think that in the eight years between 1968 and 1976 the character of the campus was changed, irreversibly, as it now appears. The Institute as we see it today took birth in those years."

In 1972, Prof. Dhawan joined ISRO as its Chairman. He was also the Chairman of the Space Commission and Secretary to the Government of India in the Department of Space. In the decade following his appointment he directed the Indian space programme through a period of extraordinary growth and spectacular achievement. He however, continued as the Director of IISc and had the ISRO head quarters setup in Bengaluru.

In his tribute to Prof. Dhawan [4], Dr. K. Kasturirangan, former chairman of ISRO, recalls his association with him in the satellite programs of ISRO and the way ISRO evolved. He mentions that Prof. Dhawan could think well ahead and it was his strategic

time that Dhawan began his career in aerodynamic research, supersonic flows and shock waves were still rather exotic phenomena; his earliest papers dealt with these subjects, and one of them, which had detailed observations of how a shock wave bounces off a solid surface (such as that of a wing, for example) became widely known for its revealing and defining observations. For his PhD thesis invented an ingenious method of directly measuring the friction drag on a surface by letting a small strip of it – about a millimeter wide – float, and measuring its effective deflection against the resistance of a spring by electronic methods, using a null technique. These results appeared in various books of the time, including the first edition of the English translation (from German, published in 1955) of Schlichting's book *Boundary Layer Theory*, the first on the subject. They have been faithfully reproduced in the many editions the book has gone through over the last fifty years, including the eighth published in 1999."

At the suggestion of Prof. Tietjens, the German Head of the Department, he established the High Speed Aerodynamics Laboratory which forcefully expressed Prof. Dhawan's personality. He established a 1cm x 1cm supersonic wind tunnel which ran

on compressed air from two war-time surplus oxygen tanks from a Dakota - complete with a schlieren system which quickly demonstrated shock and-expansion waves to students, and made them real at a time when, to most people, they were no more than fancy ideas in fancy foreign books.

This was followed by a small 1inch x 3inch supersonic tunnel and a low turbulence boundary layer tunnel. Much of the equipment and instrumentation were made locally. He also led a pilot project for the huge facilities that later came up at the CSIR-NAL. The students and colleagues he worked with at IISc went on to establish and run the National Trisonic Aerodynamic Facility at CSIR-NAL – a facility that now may well be the most well-equipped blowdown tunnel in the world.

There were two outstanding features of Dhawan's philosophy in research. First, it was carried out at low cost, with ingenious development or adaptation of whatever materials, skills and instrumentation were available at the time; second, the basic research areas investigated in his laboratories were all inspired in some way by the problems faced by the newly-born aircraft industry."

decision to have the ISRO headquarters in Bengaluru, not because he wanted to run the space programme even as he continued as the director of IISc, but because he knew that Bengaluru had several advantages. The city could accelerate satellite building activities, which had just been taken up, using the institutions like IISc, CSIR-NAL and industries like HAL and Bharath Electronics. Besides its salubrious climate that facilitated the fabrication of satellite systems, the academic, industrial and research ambience of the city were decidedly advantageous.

Dr.K.Kasturirangan adds “It was Dhawan, the original thinker, who decided the final configuration of Polar Satellite Launch Vehicle, PSLV, which is the work horse launch vehicle of ISRO today. It was his judicious decision, based on a combination of factors including technical capabilities, infrastructure, schedule, financial and project management that resulted in the unique solid-liquid-solid-liquid configuration for PSLV. He configured it keeping in view the expertise and aspirations of highly committed and talented people. He was indeed an outstanding techno-economic administrator. When PSLV had its first successful flight in October 1994, he had a sense of satisfaction. But it was only its second success that assured him that PSLV had indeed come of age. He acknowledged this when he gave me a bear hug, which I cannot forget.”

Prof.Dhawan carried out pioneering experiments in rural education, remote sensing and satellite communications. His efforts led to operational systems like INSAT- a telecommunications satellite, IRS - the Indian Remote Sensing satellite.

Dr.K.Kasturirangan recollecting Prof. Dhawan’s concern for the common man elaborates it as follows - “He was

deeply concerned about the lower strata of the society, always trying to see how they could be fruitfully employed even if they are unskilled or illiterate without displacing them or altering their pristine cultural heritage. His view of the impact of technology was very different than many professional technologists, economists, or sociologists. He expressed his views when ISRO took up the task of identifying and delineating 13 types of wastelands in the country using data from Indian remote sensing satellites. These maps are prepared and updated to help reclaim the lands for agricultural and other uses. When I took copies of these maps to Dhawan, he viewed the whole exercise from an entirely different aspect. He said “this is all very good and these maps are very useful to develop this country. But do you know that wastelands in our country are not a waste? There are tribals and others who depend on the produce of these so-called wastelands. If you start water recharging and improve the water availability in these lands to improve the vegetative cover, the whole place may look very promising to prospective developers. Then these tribals will be disturbed and there will be no system to protect them. He even cited the example of aqua-culture, initiated to bring prosperity, which resulted in several traditional fishermen and others along the coast being displaced. Even though they were given some 10,000 rupees each, they did not know how to manage that money and, within months, they frittered it away and were left in the lurch. In a lecture delivered at the Indian Institute of Technology, Chennai in February 1976, Dhawan explained how a technology related to rocket propellant, developed by the Vikram Sarabhai Space Centre, Thiruvananthapuram, could trigger developments that could benefit

millions of unskilled, illiterate and predominantly tribal population. The technology related to developing polyols using naturally available oil seeds that could lead to production of other petroleum products. The project involved collection of seeds, both cultivated and uncultivated, from Castor, Mahua, Pista, Neem, etc, de-hulling, transportation to oil extraction centres and transportation of oil. The capital investment estimated was Rs 190 crore and operating cost Rs 461 crore while the value of the product was estimated at Rs 487 crore per year. Further, it would have resulted in about 4 million tonne per year of non-polluting, non-toxic and biodegradable manure that would have significantly enhanced agriculture and food production. Prof.Dhawan was peeved when the project was shelved due to economic consideration. He felt that the feasibility study was purely an economic analysis and did not assess the sociological benefit that would have accrued to a million grassroots level population.”

Prof.Dhawan’s concern for the environment and love for nature was unique. He was a practicing environmentalist. During the selection of the SLV-3 launch complex in Sriharikota, when the site and building plans were presented to him, he was shocked at the need to remove ten thousand trees. He discussed with the team for two hours to find an alternate that met the mission requirements without uprooting all the trees. After prolonged discussions, a new site configuration emerged needing removal of only a thousand trees. He agreed to this solution stating that they should make arrangements to plant ten thousand saplings in that area. He followed this with an official order issued to all the Directors of ISRO

Establishments stating that “no tree should be removed without specific clearance from the Chairman of the ISRO, in any Establishment”.

When the Sriharikota Range was being built, he rejected a proposal to fence the range to keep cattle from it, noting that the range had belonged to the cattle and the tribals living there, and directed them for making alternative arrangements. He set up a museum housing the artifacts that were found at the launch site.

Prof. Dhawan loved birds. During his periodic visits to Sriharikota range he would go into the nearby forest and the Nelapattu sanctuary along with a photographer, looking at various types of birds and study their dynamics of flight. This fascination for the bird's flight led to a research establishing the framework for flying, wing profiles of the bird, structure and action of muscles, wing shapes and the flapping configuration for different types of birds with reference to the weight. His research was a masterpiece. For the first time the world came to know about the beautiful research work relating to flapping kinematics, hovering flights, gliding and soaring, power requirements of the flight including the establishment of drag coefficients for zero lift birds. Prof. Dhawan shared his research in the form of lectures at various forums. This work was published as a monograph in Sadhana [5].

Prof. Dhawan's one year experience on the shop floor of HAL, working as a technician and a mechanic had a major impact on him. His respect for and fascination with people who could do things with their hands was a kind of personal hallmark. At IISc, he had special administration for the skilled workers and worked at the means to support and promote them. Prof.

Dhawan could also fix and repair many things on his own. His close associates at ISRO often saw him carrying out minor repairs on many things including the air conditioner in his room. After his demise, when his family collected his personal belongings from his room in ISRO, found among them small knives, screwdrivers and other small tools.

Prof. Dhawan was honored widely for his contributions to science and technology by various bodies within India and abroad. When he was invited to deliver the Commonwealth Lecture at the Royal Aeronautical Society, he characteristically made a comprehensive review of everything that was being done in the many different aeronautical institutions in the country. He was elected President of the Indian Academy of Sciences in 1977, and awarded the Padma Vibhushan in 1981. He was one of the very few Indians to be elected to the US National Academy of Engineering. He was a Distinguished Alumnus of both Caltech and IISc. Two volumes of scientific papers have been published as tributes to him, with contributions from friends and admirers all over the world. Among his numerous other awards, one that deserves particular mention is the Indira Gandhi Award for National Integration, bestowed on him in 1999 with a citation that read in part:

*The award goes fittingly to one of our foremost scientists, teachers, and national builders, Prof. Satish Dhawan, who has made multidimensional contributions to scientific education, research, policy formulation and implementation and is deeply concerned with the solution of national problems through the use of science.*

Prof. Dhawan was indeed a great Indian personality to remember and to emulate.

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Scientist G (retd.) NAL

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# It's time we BUILD our own SEAPLANE

## Sea Plane Development in India

In spite of the long seacoast and a large cluster of inland lakes in the Indian Sub-Continent, which signifies a huge “tourism and economic” potential on

one hand, and grave security threats on the other, the number of Sea Planes in operation and the number of Sea-Plane Operators is incongruously very

low and there is grossly inadequate coastal transport network. This contrast is more remarkable when compared to other countries from both Eastern and Western hemisphere, such as Australia, Canada, China, Germany, Italy, Japan, Russia, UK and USA, including island countries such as Indonesia, Maldives and Caribbean Islands. We are late to realize and exploit the technological and economical advantages of these “maritime-air” transport systems. Exciting possibilities of networking the existing costal ports and important island clusters are obvious. (Fig. 1) Unexploited potential of the Sea-Planes also lies in interconnecting innumerable inland lakes which our Country is blessed with.



Fig 1 Seaplane Coastal Network in the Indian Southern Peninsula

Several government initiatives and private industry ventures have just started recently, heralding the dawn of serious commercial Sea-Plane

operations in India. Maharashtra, Tamil Nadu, Kerala and Andhra Pradesh are just few examples of States which are reported to have ventured into tourism-driven Sea-Plane Operations

### Seaplanes and Land-based Aircraft

A Seaplane is a powered fixed-wing aircraft capable of taking off and landing on water and come in two categories, floatplanes and flying boats; the latter are generally far larger and can carry much higher payload. (Fig 2) A variant of these Seaplanes, Amphibious Aircraft, can also take off and land on airfields. Floats of all these varieties understandably impose extra drag and weight, rendering seaplanes slower and less maneuverable during flight, with a slower rate of climb, relative to land-based aircraft.

Float planes have been mostly derived directly from land-based aircraft, with fixed floats mounted under the fuselage

instead of retractable undercarriage. Floatplanes offer several advantages, since the fuselage is not in contact with water, which simplifies production by not having to incorporate the compromises necessary for watertightness, general impact strength and the hydroplaning characteristics needed for the aircraft to leave the water.

Attaching floats to a landplane also allows for much larger production volumes to pay for the development and production of the small number of aircraft operated from water. Floatplane wings usually offer more clearance over obstacles, easy docking, transferring passengers and loading cargo, while the seaplanes are on the water.

### Operational Limitations

Main advantage of the Flying Boat design is its capability for landings in rough water. A long central float directly attached to the fuselage of the

aircraft and smaller floats under the outer wings provide the aircraft with lateral stability

Sea planes in general and Float planes in particular, can take off and land on water with little or no wave action and have trouble in extreme weather. The size of waves a given design can withstand depends on, the seaplane size, hull or float design, and its weight, limiting actual operational period. Flying boats can typically handle rougher water and are generally more stable than floatplanes while on the water.

### Application and Market Potential

Sea-Planes, whose development and deployment dates back to several decades, are challenging mix of exciting technologies of Aerodynamics and Hydrodynamics. Their use gradually tailed off after the World Wars. Due to pressing priorities to aerial vehicles during world wars, not much attention has been paid towards the development of these slow Maritime-Air transport vehicles. Surging needs of tourism and transport in remote and inaccessible areas however are focusing attention to these slow, sluggish but exciting. In the present century therefore, Seaplanes maintain a few niche uses, such as for dropping water on forest fires, air transport around archipelagos, and access to undeveloped or road-less areas, some of which have numerous fresh-water lakes. Rated next to the tourism application is the potential of Seaplanes for urban and forest fire applications This major advantage offered is unique to Seaplanes and cannot be met by any other vehicles, considering the frequency of forest fires, uncontrolled and clogged traffic conditions and exponential growth

AERO PLANE A POWERED FLYING VEHICLE WITH FIXED AND A WEIGHT GREATER THAN THAT OF THE AIR IT DISPLACES



SEAPLANE: AN AIRCRAFT WITH FLOTS OR SKIS INSTEAD OF WHEELS, DESIGNED TO LAND ON LAND AND WATER



BOAT: A SMALL VESSEL FOR TRAVELLING OVER WATER PROPELLED BY OARS, SAILS, OR AN ENGINE. TAKE OFF FROM WATER



Fig.2 Integration of Aircraft with Surface Boats and Pontoons

of high-rise buildings in all the Metro-cities of the Country (Fig. 3)



Fig. 3 Urban and Forest Fire Fighting with Seaplanes

Disaster management organizations, such as Coast Guard and NDRF, can also operate Seaplanes on a much larger scale due to their efficiency and their ability to both spot and rescue survivors. Land-based aircraft cannot rescue survivors on sea, and many helicopters are limited in their capacity to carry survivors and in their fuel efficiency compared to fixed-wing aircraft. Helicopters may also be fitted with floats to facilitate their usage on water, though limited in range. Helicopters designed for survival on water are being used with emergency floatation systems but Helicopter version of Seaplanes is indeed a technology challenge relating to design, fuel efficiency, range, operational efficiency and cost. (Fig. 4).

As already indicated, many States have launched Tourism and Commercial services with Seaplanes and there is a perceptible spurt in the participation of



Fig. 4 A Concept Schematic of a Helicopter Seaplane

Private Entrepreneurs in the induction of Seaplane industry into Tourism and Transport sectors. While Fig. 5 indicates representative burgeoning potential for Seaplane operations in India and the neighborhood, Fig. 6 highlights long and porous seacoast along with the Island regions which all fall into our exclusive economic zones and also our security concerns. Many of these gaps can be plugged with the induction of Seaplanes in a big way into our Country, augmenting

and leveraging the already existing infrastructure, operational experience of land-based aircraft, trained pilots and compliance with the rules and regulations of DGCA, AAI and other aviation regulatory organizations.

### Infrastructure for Seaplane Operations

Much of the infrastructure specific to Seaplane operations and operating procedures are already in place in the Indian civil aviation industry. Incremental augmentation of the



Fig 5 Burgeoning Potential in Indian Market

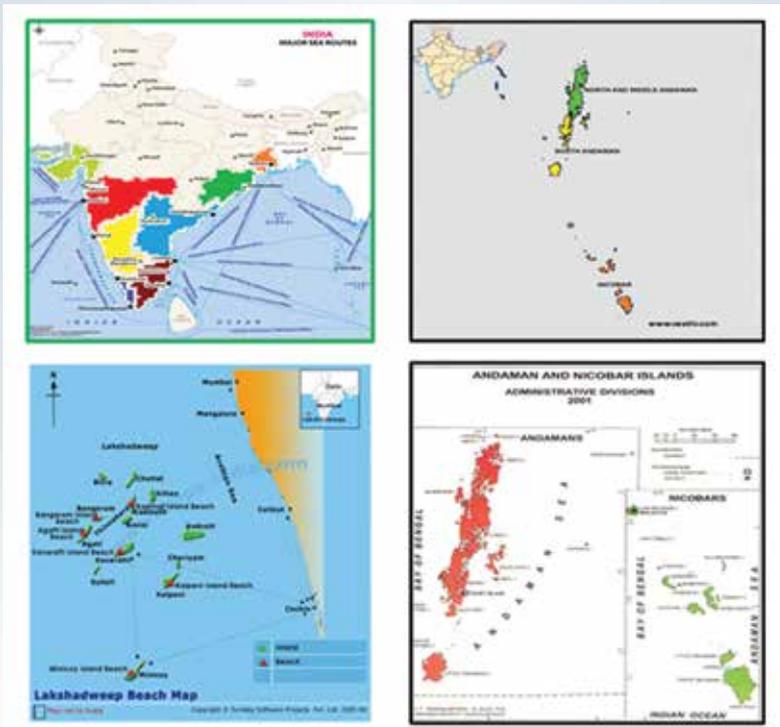


Fig 6 Homeland and Economic Security Zones

exclusive landing zones, docking facilities, passenger transfer facilities, cargo handling systems, pass port & custom control systems if required and extended ATC and Sea Port control need to be established at affordable cost, if Seaplane transportation has to be brought into affordable range,

competing with other prevailing rail and road systems. At present Seaplane km-passenger fares are relatively higher, though easy reach & access and reduced travel time are assured by the thrilling experience of limited Seaplane flights available today. Fig. 7 shows how simple typical seaport for Seaplanes could be, if



Fig. 7 Typical Seaport for Seaplane operations

integrated without disturbing the local ecological systems.

### Summary

Seaplanes hold a great promise in Indian Aviation Industry with significant contribution to the economic growth of the Country, especially in the inaccessible regions, tourism potential and relevant to present context, they will meet the challenges of efficient search and rescue operations and security threats along the long sea coast of the Country.

Most importantly, it opens the venue for exciting design and development initiatives in the Country, which is yet to launch indigenous Seaplane program, even after almost a century of aviation history. Combining complex Aerodynamics with equally complex Hydrodynamics must be a thrill and challenge to Aircraft designers in the Country indeed!



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# AIR SHOWS OF THE WORLD

Air show seasons vary around the world. The United States enjoys a long season that generally runs from March to November, covering the spring, summer, and fall seasons. Other countries often have much shorter seasons. The European season usually starts in late April or Early May and is usually over by mid October. The Middle East, Australia and New Zealand hold their events between January and March. However, the off-season does not mean a period of inactivity; pilots and engineers use this time for maintenance and practice.

The type of displays are constrained by a number of factors, including the weather and visibility. Most aviation authorities now publish rules and guidance on minimum display heights and criteria for differing conditions. In addition to the weather, pilots and

organizers must also consider local airspace restrictions. The types of shows vary greatly. Some are large scale military events with large flying displays and ground exhibitions while others can often feature just one or two hours of flying with just a few stalls on the ground. Air Displays can be held during day or night with the latter becoming increasingly popular. Shows don't always take place over airfields; some have been held over the grounds of stately homes or castles and over the sea at coastal resorts.

Before the Second World War, air shows were associated with long distance air races, often lasting many days and covering thousands of miles. While the Reno Air Races keep this tradition alive, most air shows today primarily feature a series of aerial demos of short duration.

Most air shows feature aerobatics,

and demonstrations of modern military aircraft, and many air shows offer a variety of other aeronautical attractions as well, such as wing-walking, radio-controlled aircraft, water/slurry drops from fire fighting aircraft, simulated helicopter rescues and sky diving.

With today's multi-million dollar flight lines, professional performers, and routine appearances by top-of-the-line military aircraft, it is perhaps easy to think that today's air show environment is bringing the world of aviation to the public like never before.

Solo military jet demos, also known as tactical demo, feature one aircraft, usually a strike fighter or an advanced trainer. The demonstration focuses on the capabilities of modern aircraft used in combat operations. The display will usually demonstrate the aircraft's

very short takeoff rolls, fast speeds, slow approach speeds, as well as their ability to quickly make tight turns, to climb quickly, and their ability to be precisely controlled at a large range of speeds. Manoeuvres include aileron rolls, barrel rolls, Cuban-8s, tight turns, high-alpha flight, a high-speed pass, and touch-and-go. Tactical demos may include simulated bomb drops, sometimes with pyrotechnics on the ground for effect. Aircraft with special characteristics that give them unique capabilities will often display those in their demos; For example, Russian fighters with Thrust vectoring may perform difficult manoeuvres that cannot be performed by other aircraft. Similarly, an F-22 pilot may hover his jet in the air with the nose pointed straight up, a Harrier or Osprey pilot may perform a vertical landing or vertical takeoff, and so on.

Air shows may present some risk to spectators and aviators. Accidents have occurred, sometimes with a large loss of life, such as the 1988 disaster at Ramstein Air base in Germany and the 2002 air show crash, Ukraine. Because of these accidents, the various aviation authorities around the world have created set rules and guidance for those running and participating in air displays. Air displays are often monitored by aviation authorities to ensure safe procedures.

In the United Kingdom, local authorities will first need to approve any application for an event to which the public is admitted. The first priority must be to arrange insurance cover and details can be obtained from local authority. An added complication is a whole new legislation concerning Health & Safety, which can involve the event organiser being charged with a criminal offence if any of the insurances and risk assessments are



not fully completed well in advance of the event.

Rules govern the distance from the crowds that aircraft must fly. These vary according to the rating of the pilot/crew, the type of aircraft and the way the aircraft is being flown. For instance, slower lighter aircraft are usually allowed closer and lower to the crowd than larger, faster types. Also, a fighter jet flying straight and level will be able to do so closer to the crowd and lower than if it were performing a roll or a loop.

Pilots can get authorizations for differing types of displays (basic aerobatics to unlimited aerobatics) and to differing minimum base heights above the ground. To gain such authorizations, the pilots will have to demonstrate to an examiner that they can perform to those limits without endangering themselves, ground crew or spectators.

Despite display rules and guidance, accidents have continued to happen. However, air show accidents are rare and where there is proper supervision air shows have impressive safety records. Each year, organisations such as International Council of Air Shows and European Air show Council meet and discuss various subjects including air show safety where accidents are discussed and lessons learnt.

Not long after the Wright brothers demonstrated to the world how to fly, people all over the world wanted to see what they thought was a miracle: a man-made flying machine, with a man piloting in the air, defying gravity and death. Orville Wright recalled in later years, “Flight was generally looked upon as an impossibility, and scarcely anyone believed in it until he had actually seen it with his own eyes.”

### **And so, to satisfy that curiosity, the air show was born.**

The first one was in August 1909 in Rheims, France. It was called an aviation, and it was held just one month after Louis Bleriot flew across the English Channel.

The first major US international air meet took place the following January just south of Los Angeles, and it was a huge success. 254,000 spectators showed up. The Los Angeles Times called it, “one of the greatest public events in the history of the West.” In those crowds were men who went on to write their own aviation history: Eugene Ely, the first to land and take off from a ship and four men who went on to build giant aircraft companies and airplanes that made history, William Boeing, Glenn Martin, Donald Douglas and Lawrence Bell.

**The next June, the Indianapolis Motor Speedway hosted an air meet where Orville Wright himself made the first-ever airplane flight in Indiana.**

Air meets across the USA in 1910 were often the first time an airplane had ever flown in the state. There were no rules other than the laws of nature and physics, which includes the fact that the ground is very hard when an airplane comes to earth without control. Pilots tried everything: flying through barns-which was called barnstorming - flying in formation, crashing on purpose for a film, and climbing from one airplane to another in mid-flight, which developed into wing-walking.

An air show, is a public event at which aviators display their flying skills and the capabilities of their aircraft, usually by means of aerobatics. Air shows without aerobatic displays, having only aircraft displayed parked on the ground, are called “static air shows”. Some air shows are held as a business venture or as a trade event where aircraft, avionics and other services are promoted to potential customers. Many air shows are held in support of local, national or military charities. Defence firms often organise air shows at military airfields as a public relations exercise to promote military careers and raise the profile of the military.

While it is true that the roots of the air show industry date back to the barnstormers of the 1920s and 30s,

for all practical purposes, the birth of what we know as “modern air shows” occurred with the founding of ICAS (International Council of Air Shows). The formation of ICAS allowed the industry to take a more business-like approach to organizing and promoting itself more aggressively to the general public. Air shows now had a single forum in which to discuss issues of common concern, to share ideas, and, to conduct business with performers and support service providers.

Perhaps nowhere did the formation of ICAS have greater significance than in providing a single source for working with governmental regulators and the defence. Negotiation with bodies such as the FAA and the IIC was a natural role for ICAS to fill and, in so doing, air shows were able to re-focus their attention on the challenges and details of running their businesses. Likewise, ICAS developed a close working relationship with the defence in both the United States and Canada, a symbiotic relationship that has allowed military bases to thrive as locations for air shows as well as provided the ideal venue for military acts such as the Blue Angels, Thunderbirds, and Snowbirds to become invaluable publicity tools for recruitment.

With more cooperation and efficient relationships with regulatory bodies and the defence, air shows steadily grew in number and stature throughout North America. Spectators flocked to shows to

experience the thrill of military jets, the awe of gravity-defying biplanes, and all manner of entertainment both in the sky and on the ground. By the turn of the century, air shows had become a substantial economic force in North America, with tens of millions of spectators showing up each year to enjoy an especially exciting brand of brand of family entertainment.

Meanwhile, ICAS continually redefined itself, working with members to assemble the products and services that air show professionals needed.. At the heart of the organization was the annual ICAS Convention, which saw steady growth through the years as a once-a-year opportunity for shows and performers to share ideas, conduct business, and continually look for ways to advance the industry. Outside of the convention, the organization sought the assistance of volunteers who brought their expertise to the table in assembling standards in the areas of safety, education, professional practice, and ethics that have allowed air show industry to operate with a spirit of continuous improvement that positions it well to thrive now and in the future.

The calendar of air shows is full for most part of the year and the air shows of all types run into hundreds, some have local interest while the others have global importance. It is practically impossible to include all, some of the air shows which are important professionally, commercially and have



general appeal are given here.

### **Paris Air Show**

Le Bourget Air Show, in France, the world's oldest. Established in 1909 and attracting approximately 400,000 visitors, it is held in June on odd-numbered years, alternating with the British Farnborough Air Show held in July on even-numbered years.

### **Internationale Luft- und Raumfahrttausstellung (ILA)**

ILA, Berlin Air Show, is a large air and aerospace trade show, which, established in 1909, claims along with Paris air show, to be the world's oldest.

### **Royal International Air Tattoo**

The world's largest military air show is the Royal International Air Tattoo at RAF Fairford, United Kingdom. The RIAT gathers military aircraft and military display teams from all over the world.

### **MAKS (Mezhdunarodnyj aviatsionno-kosmicheskij salon, "International Aviation and Space Show")**

The biggest air show and aerospace trade show in Russia, MAKS, is held near Moscow on Zhukovskiy LII air field. The first show, Mosaeroshow-92, was held in 1992. Since 1993, it was renamed to its current name and is held on odd years.

### **Waddington International Air Show**

The Royal Air Force's largest air show, is held annually at RAF Waddington, United Kingdom. The air show features participants from across the world and showcases the work of the RAF and its allies.

### **Sundeland International Air Show**

Sunderland International Air show is the biggest free annual air show in

Europe, held at the Roker and Seaburn seafronts. It takes place over the course of three days, usually the final weekend in July and attracts around 1,000,000 spectators every year. The air show features a large number of planes, including the Red Arrows and the Euro fighter Typhoon.. The Royal Navy traditionally have a warship off the coast every year, usually HMS Ocean. The air show was first held in 1989 as a single day show, and was planned to be a one-off event, when it attracted 250,000 spectators. Due to its success, from 1991 it became a two-day show, and subsequently three days each July.

### **Airbourne – Eastbourne International Air show**

Airbourne, also known as Eastbourne International Airshow, is a 4-day international air show run every August in Eastbourne, East Sussex, England. The event features Battle of Britain memorial flights and aircraft from the RAF and USAF, among others, and enjoys displays by Red Arrows team. Started in 1993.

### **Sun n Fun**

Sun 'n Fun (officially styled Sun 'n Fun fly in, Inc.) is a non profit organisation in Lakeland, Florida dedicated to the promotion of aviation education. It is best known for the annual week-long

fly-in and air show at Lakeland Linder Regional Airport in Florida, usually held during late March or early April.

### **Aero India**

A biennial air show held in Bangalore, India, at the Yelahanka Air Force Station. It was first held in the year 1996 and since then has become one of the largest air shows in the world.. It is the largest air show in Asia.

### **Abbotsford International Air Show**

The Abbotsford International Air show is held annually on the second Friday, Saturday and Sunday in August at Abbotsford International Airport in British Columbia, Canada. It is Canada's largest air show. It features both military and civilian aircraft from Canada and the United States, and on occasion military aircraft from other countries such as Britain, Germany, and Russia.

### **Dubai Air Show**

The Dubai Air show is a biennial show held in Dubai, United Arab Emirates. It is organised by F&E Aerospace since the year 1989; it is organised under the patronage of HH Sheikh Mohammed bin Rashid Al Maktoum, Vice President and Prime Minister of the UAE and Ruler of Dubai, in cooperation with the Government of Dubai, the Dubai Civil Aviation



Authority, Dubai Airports and in collaboration with the UAE Armed Force held since 1989 each November on odd-numbered years, after every Paris Air Show.

### **Asian Aerospace**

Asian Aerospace was based at the Changi Exhibition Centre near Singapore Changi Airport, where it was first hosted in 1981. Then the only major show in Asia, it grew to become the third largest Air show in the world. Held once every two years in Singapore since its inception until moving to Hong Kong in 2007.

### **Singapore Air Show**

The Singapore Air show, formerly known as Changi International Air show, is a biennial aerospace event held on even numbered years in Singapore starting from 2008. The event was launched as a partnership between Civil Aviation Authority of Singapore and the Defence Science and Technology Agency after the relocation of Asian Aerospace from Singapore

### **Langkavi International Maritime and Air Show**

Langkawi International Maritime and Aerospace Exhibition (LIMA) is a maritime and aerospace exhibition that takes place once every two years since 1991 in Langkawi Malaysia. The event is one of the largest maritime and aerospace exhibitions in the Asia-Pacific, and is focused mainly on the defence industry, but also supports civilian industries.

### **Istanbul Air Show**

Istanbul Air show, is organised biannually at Istanbul Ataturk Airport since 1996, is the single "Civil Only" aviation and airports exhibition in Eurasia.

### **China International Aviation & Aerospace Exhibition**

China International Aviation & Aerospace Exhibition, also known as Air show China or Zhuhai Air show, is the largest air show in mainland China. It has been held in even years in Zhuhai, Guangdong since 1996.

### **Australian International Air Show**

The Australian International Air show, also called the Avalon Air show, is held biennially at Avalon Airport, between Melbourne and Geelong, Victoria. It regularly features planes from the Royal Australian Air Force, United States Navy and the United States Air Force. It is said to be the largest air show in the southern hemisphere held every two years.

### **Warbirds over Wanaka**

Warbirds over Wanaka is a biennial air show in Wanaka, held on the Easter weekend of even-numbered years since 1988. It is held at Wanaka Airport, in the South Island of New Zealand.

### **FIDAE**

FIDAE (Feria Internacional del Aire y del Espacio) is a biennial international Air Show held in Santiago, Chile in March. The first show was held in 1980. Since 1990 was renamed to its current name FIDAE and takes place at Comodoro Arturo Merino Benitez International Airport.

### **Danish Air Show**

The Royal Danish Air Force conducts the annual Danish Air Show at one of the three Air Stations: Aalborg, Karup or Skrydstrup. Annually between 80,000 and 100,000 spectators visit the show, where various military and civilian aircraft perform flying display and static display, furthermore there

is a number of exhibitions of Danish military units and various civilian companies with relation to aviation.

New technology resulting in improved performance of the aircraft unimaginable so far, new manoeuvres of tactical aircraft, the power of the engines, the strength of the airframe all have demanded showcasing. Where else but the air shows can one witness these.



**Air Cmde Sajjad Rahim Vsm**

Air Commodore Sajjad Rahim, VSM is the Principal and Director (Academics) of Hindustan Aviation Academy, Bangalore. He is DGCA approved, Chief Ground Instructor and Dy Chief Instructor.

His qualifications include a bachelor in Science Honours, a bachelor in Mechanical Engineering, a post graduation in Aeronautical Engineering from IIT, Madras, a post graduation in Science, and a post graduate in Management. He is a Member of Institute of Engineers and a Fellow of the Aeronautical Society of India. He is a graduate of the Defence Services Staff college, Wellington.

Air Commodore Sajjad Rahim served the Indian Air Force for 33 years in various capacities, on a variety of fighter, bomber, transport aircraft and helicopters. As a Flight Engineer flew hundreds of hours of route and operational flying on Helicopter and Fixed Wing Aircraft. He has commanded Servicing Development Establishment and was the Principal Director at Air Headquarters.

He was awarded Vishisht Sewa Medal for services of high order by the President of India. After retirement was a Director of an aero engine overhaul establishment before he took over as the Principal and Director (Academics).

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## MAKING OF AN AEROSPACE ENGINEERING COMPANY, CARVING OUT A NICHE FOR ITSELF TO SERVE THE INDUSTRY

**GENSER** (Genser Aerospace & Information Technologies Private Limited), incorporated in 1997, in India, delivers niche aerospace engineering services and consulting across the aeronautical cycle of Design, Manufacturing and Aviation (in-service support), on its own, as also by harnessing and developing best-in-the-industry resources in India and abroad.

Genser was started by seasoned aerospace experts with the sole objective of facilitating growth in the Indian Aerospace Industry by connecting it to the global players. From its small beginnings, Genser is one of the familiar names today in providing niche aerospace engineering services.

In the initial stages, Genser was involved only in domestic projects of Aerospace Document Engineering (e.g. Overhaul Manual of ALH; Lakshya Manual; HANSA pilot project

of creating IETM with S1000D etc.) and sourcing of specialty components.

These initial efforts were followed by systematic reach out to global aerospace leaders and gaining their relationships in respect of all the service streams of Genser – Design Services, Manufacturing Services and Aviation Services.

In the area of Manufacturing Services, Genser did pioneering work to support India initiatives of companies like Hamilton Sundstrand (USA), Pratt & Whitney (Canada), Lord Corporations (USA), Liebherr Aerospace, Lindenberg (Germany), who wanted to develop a supplier base in India to enlarge their footprint, geographically disperse risks, gain cost advantage and be present in fast growing Indian economy. The role that Genser took was to learn these leader companies' robust processes, conduct surveys of suppliers, do gap analysis and participate in gap

closures, impart training, help with FAIs, develop and prove processes and so on. It undertook manufacturing-programme-management and contract manufacturing. Genser also consolidated its manufacturing strength by taking shares in an AS9100 accredited manufacturing company – RTPL (Rupesh Technologies Private Limited, Bengaluru) to have seamless access to a captive and nucleus manufacturing facility. This facility has proven over 200 precision structural and transmission parts of various Indian Aerospace Programmes. The facility is now also being used selectively for export projects relating to aero-engine parts and electronic chassis kits meant for ADS-B (Automatic Dependent Surveillance – Broadcast). The ADS-B chassis kit being supplied to Aspen Avionics, USA is becoming a mandatory fitment on aircrafts by 1 Jan 2020. Genser has delivered over 1000 ship sets of actuator gears to a European Single



A few typical aerospace parts produced at captive manufacturing facility or product specific supply chain of Genser



working. Genser would be signing agreements at this show to expand scope of ongoing relationships with Stirling Dynamics(UK) and Value Chain(UK). In addition, new agreements are likely to be announced in the area of aero-engines and light business jet development as a part of strengthening Make in India initiatives.

Genser calls this model by various names: Extended Enterprise, Virtual Manufacturing, Formation Flying on ground etc., which are essentially various models of teaming.

Genser has applied this teaming model for collaborative development of Aircraft Test Systems and Manufacturing support to Engineering Services Companies and many more situations.

Mr. Arunakar Mishra, MD of Genser, says that learning and operating collaborative models of working, particularly by MSMEs has many

advantages for the companies as well as aerospace industry: quicker traction for projects, shorter gestation by using available infrastructure across the teaming companies; optimization of resources, if challenges of logistics can be overcome and multi-company relationship models can be perfected.

Genser's future plans include enabling geographically dispersed operations across countries and cultures. The benefits are: cost minimization, risk distribution, access to a wider resource base, greater market reach and proximity to customers. At the same time the challenges are: modularization of work, managing work transitions and cost spikes. With our experience in executing transnational projects in manufacturing and design for some of the European & North American aerospace programmes, we understand these aspects well and have processes in place to control such transitions. We are convinced, with our unique and tested delivery

models, we can offer useful, cost-effective and quality packages of services to the industry.



**Arunakar Mishra** is MD & CEO of Genser Aerospace & IT Pvt Ltd, he founded in 1997 after a stint of 22 years in Hindustan Aeronautics Limited. He is also a promoter and one of the founder members of MISSION aero fi., Board Member of NALTech and Honorary Vice President of SIATI. Analysing aerospace businesses, marketing Indian Aerospace products & capabilities globally, setting up systems for large and small aerospace organization, entrepreneurship, relating Indian Aerospace to the world and vice versa, have been the traits of Arunakar over his professional life spanning 4 decades.

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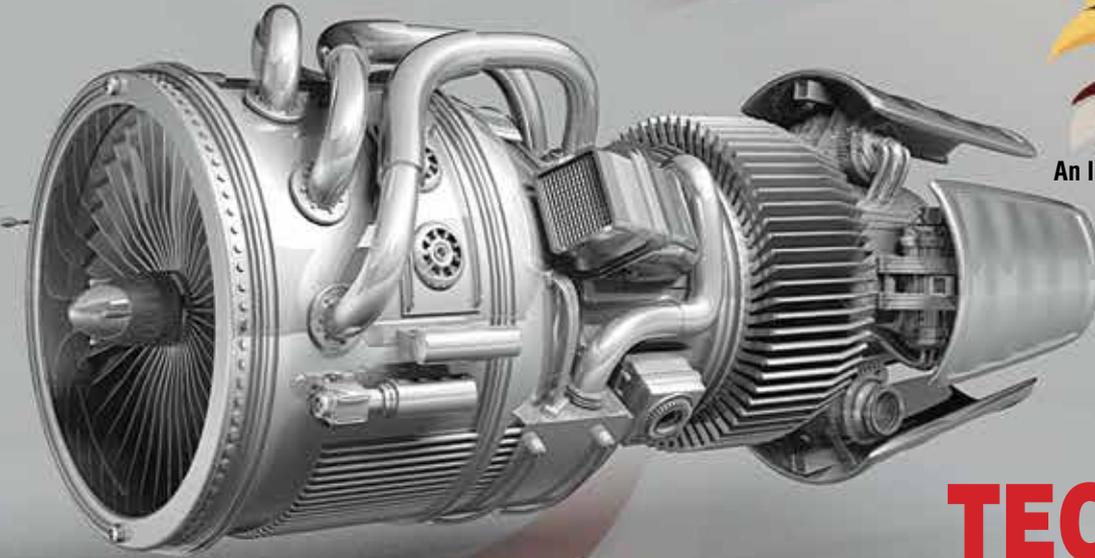
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# **SOCIETY FOR ADVANCEMENT OF AEROSPACE PROPULSION (SAAP)**



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“Society for Advancement of Aerospace Propulsion (SAAP)” was formed with a motto of bringing together the serving or retired Scientists, Engineers, Practicing Professionals, Academia and the Industries involved in Aerospace Propulsion Systems Design & Development, Manufacturing, MRO services and Airworthiness & Certification, all under one roof to pursue and benefit from the mutually possessed knowledge.

A National Technical workshop entitled “Gas Turbine Engine Trends and Technologies” was conducted on 27 February 2016, at Bangalore, to infuse knowledge among the audience through interactive sessions about the best practices adopted by the Scientists/Engineers and also to alert and alarm them about the challenges involved in development of Gas Turbine Technology in India. This was attended by over 100 delegates amongst Industry, Academia and R & D and was well received.

Further, a two day event entitled “National Workshop on Employment, Entrepreneurship & Research Opportunities in India” was conducted at Bangalore for various Engineering disciplines covering : Mechanical, Aeronautical, Civil {Structural}, Electrical, Electronics, Communications and Computer streams. There was an overwhelming response and was attended by around 95 delegates from the Academia, Industry and R&D.

The endeavor of the Society is to conduct several such programs regularly for the benefit of the Engineering community of the country.

The Society also enrolls Membership from various bodies and student community as given in the enclosed Application Form.

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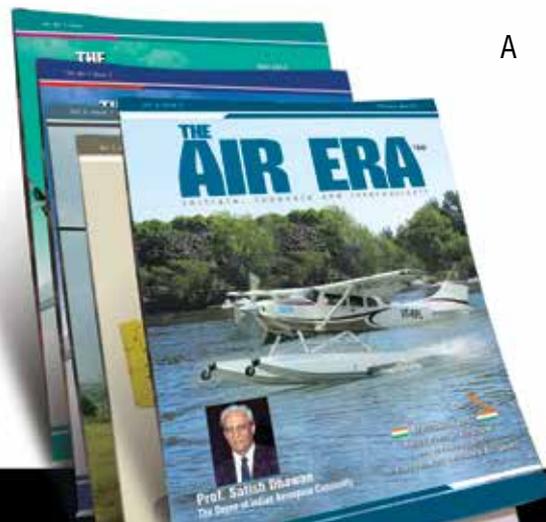
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