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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.

In this issue, we report an exclusive interview with Dr.Kota Harinarayana. He was answering varied questions from our team from an aviation student's perspective and the scope of Aeronautics 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

## ICAO On Path To Improved Flight Tracking, Conflict Zone Alerts

Spurred in large part by two disasters in 2014—the disappearance of Malaysia Airlines Flight 370 in March and the shootdown of the carrier's Flight 17 in July—the member-states of the International Civil Aviation Organization (ICAO) have agreed with few exceptions to implement a comprehensive suite of global tracking and conflict zone warnings over time, but to take interim steps almost immediately.

In response to the MH17 shootdown, the conference of 118 states and 34 observer organizations meeting for a High-Level Safety Conference in Montreal during the first week of February, decided to launch “without delay” a “simple centralized web-based repository” of threat and safety information to help air navigation service providers and airlines assess destination and overflight risks in conflict zones. Eurocontrol developed an early prototype of the system, but ICAO will operate the first implementation.

The Dutch safety board has not released its final report on the MH17 crash, only confirming in a preliminary report an external explosion, widely believed to be caused by a long-range surface-to-air missile (SAM) fired by Russian separatists that destroyed the Boeing 777-200ER in cruise at 33,000 ft. over eastern Ukraine. The downing took

place in an active military conflict zone, but high-altitude air routes remained open over the area.

A fully functional Gads, likely available on new aircraft beyond 2021, is expected to include:

Normal tracking updates every 15 min. sent to an airline's operational control center.

A tamper-proof distress-tracking mode that transmits position, time and identification updates at 1-min. intervals, activated automatically or by the crew or ground when certain attitude or system health issues occur.

An improved method to recover flight data and cockpit voice recorders.

ICAO is proposing that the distress-tracking mode be standard on new aircraft built after 2021 and that automatic deployable flight recorders (AFDR) be installed on new aircraft from 2019. As an alternative to ADFRs, airlines could use a different form of data recovery, possibly data-streaming before a crash, as an option on all aircraft from 2016.

To improve its guidance to airlines, by August ICAO plans to complete a multinational test of operator flight monitoring, air traffic services, search- and-rescue and civil and military cooperation.

## 777X Configuration Changes Revealed

**Span increases, revised flaps and new engine noise-reduction technology alter 777X's look**



*New Boeing noise-reduction technology means the GE9X nacelle (far right) will dispense with its distinctive GENx-derived noise-reduction chevrons. Credit: Boeing Concept*

Boeing's 777X design team is tasked with introducing significant structural and propulsive advances while keeping other systems changes to a minimum, so it is no surprise that in most respects the next-generation twin will be difficult to distinguish externally from the 777-300ER of today.

Yet as Boeing digs deeper into the design of the new 777-8X and -9X models that will become its flagship long-haul products for the 2020s and beyond, the company is invoking more visible changes on its way to firm configuration in mid-2015. While system changes will remain invisible, the first lessons learned from wind-tunnel tests, in addition to new propulsion-related noise-reduction technology, will result in some new external design features that differ from Boeing's initial concept.

As a result of this process, two visible changes have been made to the wing, a fourth-generation composite design that builds directly on Boeing's experience with the 787. Not only is the overall span increasing, but the outboard flap will now be split into two to stiffen the sections and guard against flutter—a potentially catastrophic coupling of the structure with aerodynamic forces. These two changes are partially connected, as the greater span drives a higher overall wing-aspect ratio, further thinning out the trailing-edge flap sections.



## After the huge success of the Mars Orbiter Mission (MOM)

After the huge success of the Mars Orbiter Mission (MOM), India's first interplanetary mission to planet Mars with an orbiter craft designed to orbit Mars in an elliptical orbit, ISRO is set to launch its next mission. GSLV Mk-III X / CARE Mission, is the first experimental suborbital flight of India's latest generation Launch Vehicle- GSLV Mk-III and is scheduled in the third week of December 2014 from Satish Dhawan Space Centre SHAR, Sriharikota.



www.aeromobil.com

# THE FUTURE OF TRAVEL AEROMOBIL

**A**eromobil Beautifully integrates the concept of dreams into reality. Aeromobil 3.0 transforms in seconds from an automobile to an airplane. AeroMobil is a flying car that perfectly makes use of existing infrastructure created for automobiles and planes, and opens doors to real door-to-door travel. As a car it fits into any standard parking space, uses regular gasoline, and can be used in road traffic just like any other car. As a plane it can use any airport in the world, but can also take off and land using any grass strip or paved surface just a few hundred meters long. The current flying car prototype

AeroMobil 3.0 incorporates significant improvements and upgrades to the previous pre-prototype AeroMobil 2.5. It is now finalised and has been in regular flight-testing program in real flight conditions since October 2014.

The AeroMobil 3.0 is predominantly built from advanced composite material. That includes its body shell, wings, and wheels. It also contains all the main features that are likely to be incorporated into the final product, such as avionics equipment, autopilot and an advanced parachute deployment system.

AeroMobil 3.0 also implements a number

of other advanced technologies, such as a variable angle of attack of the wings that significantly shortens the take-off





requirements, and sturdy suspension that enables it to take-off and land even at relatively rough terrain.

The flying car, which was built in only ten months, made its world debut at the Pioneers Festival in Vienna on October 29. The company that produced it, AeroMobil, is based in Slovakia and has been at it since 1989. In 2010, with their release of AeroMobil 2.5, the team hit a major milestone when their flying car took off and received certification by

the Slovak Federation of Ultra-Light Flying (SFUL) as authorized by the Civil Aviation Authority of Slovak Republic. AeroMobil 3.0 has now entered a regular flight program in Slovakia and has been undergoing extensive flight-testing since last month. While this model won't be for sale, it does bring the company closer to having a flying car that is.

“Currently the AeroMobil 3.0 prototype will serve two main

purposes,” the company said in a statement. “First, it will be used to test and improve the final performance, features, and characteristics. Second, it will be used for initial marketing purposes, including presentations at major trade shows.”



# VENERABLE GRAND OLD LADY

## DC-3 DAKOTA

In 2010, 107 years after the Wright Brothers' historic flight at Kitty Hawk, an aircraft celebrated its 75th anniversary. The celebration was across the globe, as this aircraft had touched all parts of the globe including the Polar Regions. The aircraft is none other than DC-3 Dakota, the most important aircraft in the history of aviation.

High point of the celebrations was the fly-ins of Dakotas in immaculate condition. While the July 24-26, 2010 reunion at Whiteside County Airport, (KSQI), Illinois had a record 26 DC-3's

and a DC-2, at Oshkosh EAA Airventure it was even better. A record 57 DC-3 Dakotas are suppose to have converged there.

The story of DC-3 Dakota is unique. For nearly eighty years it has held its admirers and fliers, in spite of great advancement in Aviation technology. Few years back, in the aviation website airliners.net a simple question was raised – “Why Dakotas are still flying?” Following are two of the many replies.

*DC-3s will continue to fly well into the 21st century due to the skill of many of the operators that still fly them. It's quite likely that many of the ones operating today will still be flying when they hit the century mark. Statistically you are safer flying aboard a well maintained DC-3*

*with a pilot of average or above average proficiency than aboard almost any other type of airplane. Flying since 1937 with so many of them remaining in operation and never having been grounded by any government agency on account of safety says something about the type's quality. I'd fly any US registered Douglas propliner that is certified airworthy without any second thought.*

*For one, the DC-3 as well as the -4, -6 and -7 all hail from the days when aircraft were overdesigned and overbuilt. Also, neither the DC-3 nor-4 was pressurized. Therefore, metal fatigue from repeated pressurization cycles is not an issue. Economically they are more competitive than a turboprop due to operating costs and available cargo capacity (both weight and volume). The old saying was that if you could fit it through the cargo*



door, the C-47 could carry it. Another point is that they are very easy airplanes to handle for something of their size. Unless you intend to kill yourself, you won't in a DC-3.

My association with Dakota is more than five decades old. As a boy, I was intrigued with the word 'Dakota' being used for any vehicle that is considered a junk, e.g., a truck, car or a bus. This sobriquet baffled me. Few years back there was a regional movie (Kannada) "Dakota Express", the title referring to an old bus!

My father, who worked at the Overhaul Division of HAL, had worked with many Dakotas and once travelled as far as Jorhat in Assam to restore a damaged one. At home, we had a photograph of a Dakota airplane at Bangalore airport that brought the ashes of Mahatma Gandhi, which was framed along with our photos. My father told me that it was a nice airplane and had even bought me a reasonably good replica of Dakota made out of sheet metal.

Thus started a strange love and admiration towards Dakota and, as I grew up, I realized that associating the



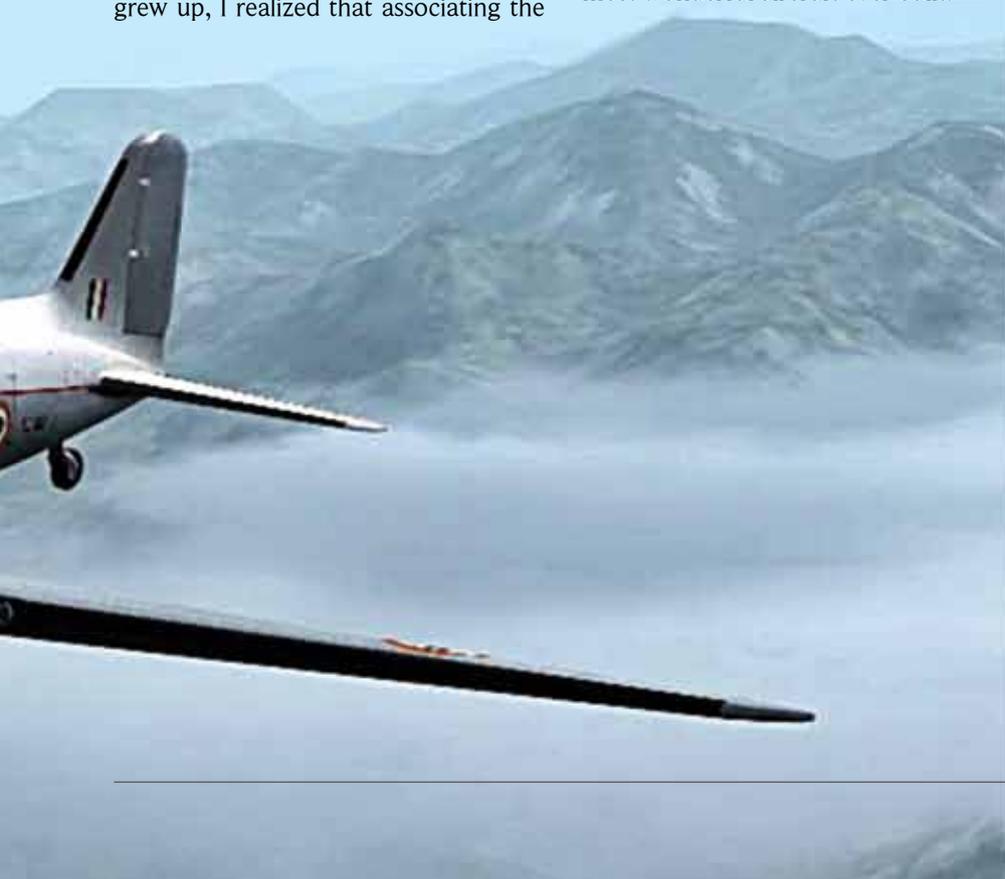
word "Dakota" to a "junk" was almost akin to sacrilege! This venerable "Grand Old Lady" which adorned the skies for nearly eighty years deserves far greater respect.

DC-3, Dakota, Gooney Bird, Sky Train, C-47, Dak, Gallant R4D all refer to the same aircraft. While the airlines called it a DC-3, USAAF called it C-47 and Sky Train, for the navy it was R4D and for the Tommy it was a Gooney Bird. The RAF called it 'Dakota'. Talk to an airman who was with a Dakota and he would swear by it and say that it is probably the most wonderful aircraft ever built.

Technically, Dakota is a marvel of its period. Like it is typical of many great aircraft, its birth was quite unique. Boeing had come up with B-247, an all-metal transport airplane. DC-3 was designed & patented by chief engineer James H. Kindlerberger (Dutch) & designer Arthur E. Raymond to compete with Boeing B-247. It was initially conceived as Douglas sleeper transport (DST) with fourteen sleeper berths to fly passengers from US coast to coast. But the moment berths were replaced by seats it proved to be a vehicle capable of producing profit without the govt. subsidy in the form of airmail.

The DC-3 made its first flight on 17th Dec. 1935, the 32nd anniversary day of the Wright brothers' first flight. It was a day when the first airliner took its maiden flight and dawn of the era of profit making simply by carrying nothing but passengers from one place to another. The 21 seat DC-3 came on the scene in 1936. American airlines were the first to use it and on June 25th 1936 the first established profit-making route (New York to Chicago) was born.

The DC-3 incorporated all the technological advances of mid-1930's; reliable, high-power air-cooled piston engines; cowl flaps to control the cooling airflow through its engines; variable pitch metal propellers; duralumin alloy fuselage and wings; a strong retractable



landing gear to allow landing on rough landing strips; flaps to allow it to land on short runways: and an electronic auto-pilot.

With a fuselage length of 64½ ft and a wing Span of 95ft it was big and beautiful. With 1,200 horsepower from each Pratt & Whitney engine, it cruised at a remarkable 145 knots at altitudes of up to 10,000ft. It could carry 21 passengers in an unpressurized cabin, over a nonstop distance of 700miles at half the cost of its predecessors. With the gross weight off 24,000lbs, a ceiling of 20,800ft, and a range of 2,125miles with maximum fuel, it soon became popular.

Five years after its appearance, DC-3 carried over 80 percent of U.S. domestic airline passengers, due in part to its strong safety record. Almost single-handedly, the DC-3 had made air transportation an economically viable business! In Europe, KLM of Holland was operating 24 DC-3's, using the aircraft to fly the 14,000 kilometer long route to the Dutch East-Indies.

Out of over 13,000 plus Dakota aircraft built over a span of 15 years, few hundreds have still survived and get airborne over the world. Many of these old ladies are used to ferry cargo in obscure areas, as antique airplanes for joy rides and occasionally show up in air shows, bringing a loving glitter in



the eyes of those who love the airplane. It is probably the only transport aircraft manufactured in large number elsewhere. It was built in large numbers in Japan and Russia. What's more, some of these are still work horses for airlines & the military in various roles that one would still find it hard to believe. Today, the DC-3 is still finding its greatest use in specialized roles with some third world countries.

After the end of second World War, General Dwight Eisenhower listed Dakota as one of the four pieces of military equipment most vital to the Allied victory. That was a true tribute to Gooney bird. How can one forget the role of Dakota in the Invasion of Normandy on the D-day. Having seen that movie 'The Longest Day', the sound of Dakotas flying still rings in my

ears. It is not jet noise but music.

If one goes through the history of this great lady, she has served in many unique roles. Apart from being a great transporter of her era, she has participated in some unique and memorable events. In July 1948, when the Russians cut off the land route between Berlin and Western Europe, six RAF Dakotas started daily flights to Berlin with food and other supplies.

In India, Dakotas had already made their name. Many private airlines – Tata airlines and others were already operating. When Air India was formed, these Dakotas embarked on international flights.

Dakotas were also inducted into the Royal Indian Air Force's Transport Squadron. In September 1948, these Dakotas created a new world record of flying at heights of 24000ft, nearly 8000ft above their safe cruise altitude, while participating in Kashmir operations.

Post Indian Independence, "Mysore" – the Dakota owned by the Maharaja of Mysore, late H.E.Jayachamarajendra Wadiyar, served as a VVIP aircraft crisscrossing India with Sardar Vallabhai Patel and contributed to the integration of many princely states to the Indian Union.

Dakotas have also assumed a new





avatar, thanks to the companies that convert them into modern machines, replacing their engines with turbo-prop, strengthening the structure, and upgrading the cockpit with modern avionics. These turbo-props are serving some air forces.

The Basler BT-67 is a fixed-wing aircraft produced by Basler Turbo Conversions of Oshkosh, Wisconsin. It is built on a retrofitted Douglas DC-3 airframe, with modifications designed to improve the DC-3's serviceable lifetime. The conversion includes fitting the airframe with Pratt & Whitney Canada PT6A-67R turboprop engines, lengthening the fuselage, strengthening the airframe, upgrading the avionics, and making modifications to the wings' leading edge and wing tip.

There are teams that have restored the Dakotas to their original glory. These flying Dakotas are flown on special occasions. In San Francisco, The Flagship Detroit Foundation has restored a DC-3 to its original glory as the American Airlines 'Flag Ship'. After ten years, now it is looking for funds from the public to keep it flying. An IAF Dakota is supposed to be undergoing restoration in UK so that it can fly again as a heritage plane of IAF.

Venerable Grand Old Lady is sure to see her hundredth anniversary. There is an old saying "the only replacement for a DC-3 is another DC-3" and as I conclude, I believe this still holds true in the centenary year of DC-3 Dakota. DAKOTA IS STILL ALIVE, LONG LIVE DAKOTA.



**Dr. M.S. Rajamurthy**  
Scientist 'G' (Retd.),  
CSIR-NAL

Dr. M.S. Rajamurthy, is an independent consultant for Flight Mechanics, Flight Safety and Flight testing. During his career from 1973-2005 at CSIR-NAL, he contributed to the development of first indigenous motion based research simulator, Human pilot modeling, flight testing of DO-28 D1 Aircraft in Germany, Fabrication & Flight testing of LCRA. During 1986-89, he worked on LCA as Deputy Project Director, Flight Mechanics and control group. He developed a novel technique of generating flight dynamic data using remotely flown scaled models in wind tunnel and in flight. At the time of leaving NAL he was Sci-G and Associate project director responsible for flight testing of SARAS prototypes. During 2006-12 as Flight safety specialist, he contributed to the operational flight safety of Kuwait Airways, through safety research and in-house flight Flight safety magazine which was even acknowledged by other Middle East airlines for its content and quality.



DC-3 "75th Anniversary"

# Finding Employment as an AVIATION MAINTENANCE TECHNICIAN

So, you have finished school. Now what?

That is exactly the question I had after I graduated from school with my Associates Degree of Applied Science in Aviation Maintenance and held my Airframe and Power Plant license in my hand. Excitement swirled through me as I thought of the two years of hard work, determination, and sacrifice I made to achieve what I was holding: my future.

Being optimistic, I put together my very slim looking resume. I did my research through newspapers and magazines. I sent out hundreds of resumes to aviation companies: repair stations, general aviation, and airlines. I reached out to them all. I went to the local companies, and knocked on their doors, collected applications, and spent hours filling them out, all to no avail. I heard the same thing:

Human Resource Office: Do you have experience?

My answer: No, I am straight out of school.

Result: I didn't get hired.

I almost gave up. Almost.

Through a series of events I applied for a company in the city of Abilene, Texas, population approximately 120,000, with an Air Force Base and a Regional Airport. Within this regional airport was a company called Eagle Aviation



Services Incorporated (E.A.S.I.) who were contracted to work on the American Eagle Aircraft.

After filling out the application, I went about my business when I received a phone call from the human resource department and they wanted me to go to Dallas, Texas for an interview. I did and I had to go through a series of tests. After passing the entrance tests, I was brought in for the interview. I passed the interview and was sent down to have a physical and drug test on site. Once the results were in that I passed, I was taken back upstairs where

American Eagle presented me an offer. But there was a problem and that one problem left me without an aviation job. They wanted me to move out of Texas and, at that time, I couldn't because of family reasons. I told them I couldn't move and they asked if they could put my resume in their file until a position came available in Abilene, Texas. Disheartened, I said yes, but inside I didn't believe they would call. That was in July of 1999. In November of 1999, I received a phone call asking me if I was still interested in the job in Abilene as an Aviation Mechanic (A&P). I said yes. Because all of my information was still

on file, they gave me a start date and in December of 1999, I began my career in Aviation. Fifteen years later, I am in the quality department of a well known company and have enjoyed my time in the aviation business as an aircraft mechanic, avionics tech, supervisor, and quality control.

Now you know more about me than you probably want to so let us get back to you. You are freshly graduated from school and want to enter the aviation industry, how do you get around the catch 22 of not having (or having limited) experience? Here are a few suggestions to help you on your path:

**1.) Be willing to relocate.** If you are single, this shouldn't be a problem for you. However, if you have a family it becomes more complicated. Sometimes, the partner has to work away from the family in order to get the experience necessary. Three years is the minimum magic number. Three to five years is preferred. If you work as an aviation maintenance technician, avionics technician, or in engineering - stay with the company for a minimum of three years before moving on. Why move on after three years? For better pay. Most of the time it takes a long time to move up in a company and your pay will stall. In fact, you may notice others being hired in making more than you are. If you go to a different company having 3-5 years of experience, you will be hired at an increased rate of pay.

**2.) Be willing to work any shift:** days, swings, nights, weekends, or rotation. When offered a position when you are first starting out, you have to take what is available. There are many kinds of shifts available. Here, in the United States, there is also what is known as a weekend shift. The mechanics on this shift work three twelve hour days (Friday, Saturday, and Sunday). The turn about is the company pays them for forty hours although they have worked

thirty-six hours and the employee has Monday through Thursday off to spend with their family. This is a win – win situation for many mechanics and companies. The company wins by having consistent coverage on the weekends.

**3.) Be willing to start at the bottom.** No job is beneath you in aviation when you are first starting out. If you have to remove the lavatory and clean it. Well, then you do it without complaining. Attitude determines career altitude.

**4.) Research.** Look up aviation companies on the internet and call the human resource department. Inquire about apprenticeship and/or internship programs. Many companies are looking for entry level technicians.

**5.) Volunteer your time.** Go to your local airport and hang around with people on the weekends. Form personal relationships and from there you will hear about job openings. Learn. Apply your knowledge.

**6.) Search for job/career fairs and attend.** Dress nicely, and have multiple copies of your resumes to hand out to potential employers.

**7.) Use Social Media.** Join Linked In and search for aviation companies and jobs.

**8.) Take online free courses to boost your resume.** Visit the Federal Aviation Administration website [https://faasafety.gov/gslac/ALC/course\\_catalog.aspx?view=AMT](https://faasafety.gov/gslac/ALC/course_catalog.aspx?view=AMT) to get started. Print the certificates and included them with your resume. List them on your resume.

**9.) Try the United States:** If you decide you want to try a job in the United States you must do two things first. Attain a passport and get a work visa. Check out this website to do this:

<http://www.ustraveldocs.com/in/index.html?firstTime=No>

**10.) Aviation hiring websites:** Visit [www.jsfirm.com](http://www.jsfirm.com). Look into companies who are hiring in the United States. Many have contract companies who hire for them. Get the contact information of the contract companies and email them asking if they sponsor persons from another country to work in the United States. Goggle other websites like: [www.aviationtoday.com](http://www.aviationtoday.com) [www.aviationweek.com](http://www.aviationweek.com) [www.aero-mag.com](http://www.aero-mag.com) <http://www.aeroindustryjobs.com>

It can be intimidating trying to break into the Aviation Industry; however, the payoff for the time and research put into finding employment will be well worth it. Don't give up.



**K-Trina Meador** is a Quality Inspector located in Oklahoma. She holds her airframe and powerplant license and her Federal Communication Commission certificate. She has served as an aircraft mechanic, avionics technician, and quality inspector since 1999. Airframes worked include Saab 340, Embraer 135/140, KC135, P-3, King Air 200, Gulfstream 550/650, Boeing 737 and 787, MD80, Beech 1900, Caravan 208 and CRJ 200/900. In addition, she is an author of six fiction titles penned under the name K. Meador.



# MAKING OF A CHIEF DESIGNER

## INTERVIEW WITH DR. KOTA HARINARAYANA

*Q 1. Being the driving factor of India's dream of building an indigenous fighter aircraft, you have become an inspiration to the Indian youth enabling them to pursue aviation as well as dream beyond one's limitations. We would like to know how or what inspired you to take up aviation.*

I completed my Bachelor degree in Mechanical Engineering from Benares Hindu University (BHU) in 1965. During that year, due to the Indo-Pak war our final year was curtailed and ended six months early in January, as there was an immediate need for engineers.

The war was in full swing and it was the first time that combat aircrafts were used by India. Aircrafts were not used in 1947 or the Indo-China war of 1962. In 1965, as combat aircrafts were used, the

air dominance was a deciding factor in the outcome of the war.

Our Air Force used Gnat aircraft extensively. The Pakistan Air Force (PAF) had much superior F-86 Sabre and F-104 Star fighter. Gnat was a small swept wing fighter developed by Folland Aircraft Company of UK. Gnat was produced under licence by Hindustan Aircraft Ltd. In the 1965 war, there were a lot of dog fights and the Gnat aircraft did quite well against F-86 Sabres and earned the title "Sabre Slayers". We were fascinated to see how a small aircraft could do so well in the aerial combat. There was an immediate requirement for more aircrafts as it was important for the defence of the country. Thus I was inspired to look at aircraft and was

attracted to Aeronautics.

In those days, there were only three institutes which offered post-graduate courses in Aeronautical Engineering. These were Indian Institute of Science (IISc), Madras Institute of Technology (MIT) and a college in Chandigarh. As I was keen to get into Aeronautics I applied to IISc and I was offered direct admission based on my marks. Had they called me for an interview, probably, I wouldn't have gone. I joined IISc and this was a major turning point.

Unlike at BHU which was mainly a teaching institution and research was not much, at IISc every professor was an active researcher. Prof. Satish Dhawan was the Head of Aeronautics department. Dr. V.M. Ghatge who was

instrumental in the design of HT-2, Pushpak, Krishak, and later HJT16 was our former HOD during 1942-1947. He was one of the few trained Aeronautical engineers. The faculty members were not only great researchers but were established giants in their fields.

In those days, Mathematics and foreign language was compulsory. It was tough for me to get adjusted to the way IISc used to teach. They had semester system and their use to be surprise class tests. It was of a great value, but also created great problems. All professors conducted oral examinations. Though Aeronautics has lot of Mathematics, understanding the concepts were equally important. The oral exam's stress was on understanding the basic concepts. The questions were like - what do you mean by stiffness? What is L/D ratio etc? If these concepts were not clear we would fumble.

There was a professor called Seetaram Murthy under whom I did a project on aircraft Stability and control. He instilled a lot of interest and while doing the project, I developed a greater feel for the subject. It was a very good learning experience. Aircraft is an integrated approach of aerodynamics, stability, control, performance, avionics, systems etc. Looking at it as an integrated approach than from a single point of view enhanced our knowledge of an aircraft. Our interest in design was generated there.

*Q.2. Having started your career in 1967 at HAL, later moving to DRDO HQ in 1970 and then re-joining HAL as the chief designer in Nasik division in 1982, how did all these experience amalgamate or form in to LCA Tejas?*

During my studies, Hindustan Aircraft Ltd (HAL) had come for campus recruitment. Those days, it was common for the students to proceed to USA or continue with the PhD program. I decided to work in industry. I got into HAL as I was really interested to look at the aircraft in totality. I joined the Flight

testing division. I was lucky to work under some good bosses and I worked on HF-24 and HJT-16 in 1967. I was involved in weapon integrated trials. The flight test was carried out in Jamnagar which was the only place in India where live weapon test was carried out.

Gun integration on to the aircraft was not an easy job. During this, pilots worked closely with the flight test instrumentation team. Stability, control and performance of an aircraft were analysed. Drag and Lift coefficients were tabulated for a particular weapon. When a weapon changes, all the accompanying characteristics also changes. As a result knowledge of aircraft was important. It was a learning process.

My bosses were good. If you were willing to do more work they would give more work. They used to sit and help out if we were getting stuck in the process.

During that period, a few people who studied at Cranfield Institute, UK joined the analysis team. They shared new techniques that were used in Cranfield institute. While in HAL, I got a direct experience on working on a fighter as well as a normal passenger aircraft. Then I got bored and wanted a change. So I applied for a job in DRDO at Delhi. During that time getting into DRDO was not easy. We had to go through Union Public Service Commission (UPSC).

I got placed in the Directorate of Aeronautics in Dec.1970. I had an extraordinary boss in AVM Krishnamurthy. Usually, Delhi means files work, but, he created a project team and brought in experts from Electronics, Mathematics, Aircraft structures, Stability, Control etc and asked us to work on the conceptual design of an Advanced Strike Aircraft(ASA). He made me in-charge of the group even though some were senior to me.

Before I got the job order in DRDO, due paper work, there was three months gap. During this time, AVM

Krishnamurthy had intimated the topics for my study. I was able to interact with the AJT-16 project head Mr.P.Raj Mahindra, Aircraft performance group in GTRE, and Dr.S.R.Valluri, Director of National Aeronautical Laboratory (NAL). In the process, I met a half dozen people involved in performance analysis and learnt a lot in those three months.

Using RAE data sheets as the basis, we developed a computer program for estimating the aerodynamics, performance, stability and control characteristics of the aircraft. At that time IBM 360 was the main frame computer available at the Delhi University. Compared to present computers it had only 100th of a capability. Programming during those days was done in FORTRAN language and punch cards were used. There would be 1000 punch cards and all corrections would be done manually. We took 8-9 months to have a viable program. These were empirical solutions. It gave us an understanding of this discipline. It was important to understand, work together and gel.

We made a layout from the little data available. We worked day and night. There was neither the luxury of tea or coffee nor the transport facility. We had to walk nearly a km to buy our dinner. But the challenge to do a conceptual design as well as the support from bosses kept us inspired. While we worked for so long hours, when we showed the results to our boss, he would point out a mistake in a minute. It took me many years to understand how he found out the mistakes so soon. We have to develop a feel for the subject. When you see the shape of an aircraft, you should be able to feel how it flies. Once you develop a feel you would understand how everything interfaces. Implications of stability, control and its importance and the feel were developed while working for the project. My project, my training and my work in Delhi gave me a feel. Of course we were enthusiastic and

not scared to commit mistakes. In eight years at DRDO, the feel increased. But the project was stopped and again I got bored.

During my stay at DRDO, I developed a deep relation with the Indian Air Force (IAF). I understood the tactical and strategic needs of a fighter. The different aspects of close support, air strike, and air superiority aircrafts were discussed with them and they also were interested in sharing their knowledge. We got to know how a fighter is used in a battle field and the customer needs. The interaction with IAF helped me to understand the need of aircrafts and the limitations.

In 1975, I rejoined HAL as the Chief Resident Engineer (CRE) in the Nasik division which was manufacturing Mig-21 aircraft. I was basically into military airworthiness and my job was to certify the aircraft following any changes undertaken. I noticed that even though we were manufacturing the aircraft for more than a decade, almost all parts were still imported from Russia. When I looked at the aircraft more closely, it was a beautiful aircraft but there were improvements that could be incorporated into the design. I was interested in increasing the indigenous content of the aircraft. So we formed a team that consisted of test pilots, CRE, etc and did a detailed study. We found Mig-21 components were very bulky. By reducing their size, we could save space and use it to increase fuel capacity.

At that time, Mig-21 had no drop tanks on the wing. Before I had come to HAL, IAF had tried fitting drop tanks on to the Mig-21. This was abandoned later due to the reduced handling qualities of the aircraft. They had carried out around 20 flight tests and collected the data. With my background in flight testing, I thought, I could look into it and may be suggest some solutions. The results from the stability analysis carried out by IAF were looking funny. In those days, paper recorders were used for on-board

data recording. The recordings were poor and accuracy was less. There were two rogue points due to which curve fit was showing a funny trend. Once we removed the two rogue points the fit was perfect.

When you put a drop tanks on the wing, the aerodynamic centre moves a bit forward resulting in the reduction of stability. The stability margin was reduced from 5% to 3%. It is not unsafe but the pilot will feel that the aircraft is not behaving like it used to. We had to prove to the pilot that the aircraft was still safe to fly. To maintain the same margin, we moved the c.g. forward with ballast and asked the pilots to fly with the drop tanks. The pilots did not feel any changes in flight characteristics. We slowly reduced the ballast till the point we completely removes it. The pilot did notice some changes in the flight

characteristics but now, he was ok with the handling qualities.

In 1980, we developed a concept called vortex plate. We didn't realise at that time that we were the first in the world to come out with this concept; NASA came up with it five years later. Dr.D.M Rao of ViGYAN Inc. had done extensive work on vortex systems like vortex flaps, pylon vortex generators etc for delta wings. As Mig-21 had a delta wing, we wondered as to why we can't try these concepts.

With the vortex plate, the aerodynamic force vector is rotated forward, and this results in a thrust component. To ascertain the benefits of vortex plate, we carried out tests in the HAL low speed wind tunnel. We found that our configuration was really great. Now, we had to prove the same in a high speed wind tunnel. We did the tests in NAL with two configurations. Results were not that great but still it was good.

Apart from this, we did studies on weight reduction by introducing composites, which in turn would lead to increased performance. We showed it to our bosses. We spoke to Dr S R



Valluri, Air Marshall Gole and Gp. Capt.Chennakeshu. They were also interested.

A two day conference was planned to present improvements in aircraft and discuss with the concerned parties. Presentation was to be done by the chief designer, but he fell ill and I was given the opportunity to present it. IAF showed a lot of interest and was ready to fund if I took over as the chief designer of this program.

Mean while I decided to pursue my PhD from IIT-Bombay. My research topic was design for air superiority fighter for India. It was not a normal research topic, but I really wanted to do research involving the whole aircraft. IIT was not ready to accept my proposed topic. Around the same time, an MIT, USA student published a paper on small civil aircraft. I referred this to IIT and asked them to permit my proposed topic. This time they accepted.

To optimize the design for combat, I developed a computer program to simulate combat using basic game theory with 1 on 1 and 2 on 1 etc. As I mentioned before the Gnat aircraft was better than its counterparts even though it was a smaller aircraft. Therefore the criteria for design are more than just speed or size.

Developing a program for simulating close combat took almost two years. It was a crude and involved multi disciplines. At that time,

the best computer was at TIFR, Bombay. I used to go there in the morning and return to IIT campus in the night and again go back in the morning. It was a tough job but it was creative and new. I finally submitted the thesis in 1982. PhD is a lot of hard work demanding 16-18 hours every day, but the culture at the IISc helped me.

At Nasik, we understood the concepts seeing Mig-21 aircraft which helped to create the programs. The near threat to us was Pakistan and looking into their powers gave us the requirements. It was a lot of learning. During this period IAF did not fund us. But HAL chairman funded us and gave us a deadline of 36 months. We flew the aircraft even before that. The aircraft showed much better performance.

Dr V.S.Arunchalam who was heading DMRL and his team worked on the brakes on the aircraft. In few months, there was tremendous progress and 50% of the work was completed even before the project sanction. Dr V.S.Arunchalam funded the project.

We looked into advanced composite technologies. The air brake was completely made of composites. NAL fabricated a composite rudder for Mig-21. This gave us some extra- ordinary knowledge. To modify a supersonic aircraft, we needed lot of courage and conviction. The composites technology developed was the first in the country. HAL however took a decision not to convert it into a full-fledged design.

This allowed me to go to Bangalore as the Director

of ADE as this post fell vacant with the resignation of AVM Krishnamurthy. During 1984, I had zero knowledge on LCA and zero involvement. Bangalore people always think that outside Bangalore nothing is happening. After six-eight weeks they asked me if I am ready to take over as the programme director of LCA. Risk levels were high and no one was ready to take up the job. LCA wanted the best of everything. It was challenging and so I agreed.

While working on many developments on the MIG-21, I had found that once there was a problem statement people wanted to work, but there was no focus or goal.

With LCA, we had a focus. Prof. Roddam Narasimha, the then director of NAL, was very supportive. Air Marshall MSD Wollen, the Chairman of HAL was enthusiastic and agreed to support us. He deputed a part of the HAL design team to work full time on the LCA programme. While many had joined ADA, NAL and DRDO deputed their scientists for the project. Professors from IITs also came forward to help us. The entire project team consisted of 300 people. Dr M.S.Rajamurthy, who is with you today, came on deputation from NAL.

We were to make a project definition, which included Systems design, Aerodynamic design, Avionics, Flight control, Maintenance philosophy, man power and cost.

Dassault Aviation (then AMD-BA) was our consultants who were helpful to certain extent but were very secretive about critical areas like Flight Control, Composites etc. But we were confident that we could do it.

We completed the Project Definition Phase (PDP) in one year. It took much longer to get the funds. During 1986-1988, feasibility report was prepared which took 15 months. IAF was not sure if we could achieve it, and the Government gave funds to make



Technology Demonstrators TD-1 and TD-2.

We started the detailed design with an aim of doing maximum work in India. Now there was a huge team of 300 industries, 40 R&D laboratories, 20 Institutions, and IITs. We had a lot of problems. Lack of infrastructure to accommodate a project of this kind was not available in our country. HAL Prototype shop was old and needed to be completely rebuilt.

A national team was formed with scientists from NAL, CAIR, and ADA to develop the control laws under the leadership of Dr.S.Srinath kumar of NAL. IAF gave a clearance in 1990. In 1991 government sanctioned 2000 Crores for the project and funds were released in 1993.

Dr A.P.J Abdul Kalam became the Director General of ADA. He was a great man and knew how to run a complex programme. He could understand trials and tribulations of the project.

The amount of indigenous content developed for LCA was the highest achieved in India. Control laws; fly by wire, composite wings, etc. IN 1998, following the Pokhran Nuclear tests, U.S imposed sanctions. It was painful but good as the ban somehow turned a boon to us. We developed control laws and built an iron bird and flew it even before US lifted sanctions. With VSSC Trivandrum, we developed direct drive servo actuators. Four of our engineers were stationed permanently for this work. We are the second in the world to develop them. With 2000 engineers/scientists, 5000 including technicians, zero infrastructure, we were able to learn on the job and create a world class fighter. From a Stable Mig-21 to an unstable aircraft which could go out of control with an error of 300 milliseconds, it was a great stride. He was an experimental test pilot. Cemilac oversaw the validation of Control laws. Even they were learning on the job as

they had not done anything like this before. It was a quantum jump from HF-24 Marut to LCA. LCA has reliable and excellent handling qualities and is capable of reaching an AOA of 26 degrees. We set up a National flight centre with state of art facilities. LCA test pilot was Sqn.Ldr. Rajiv Kotiyal.

BARC, Trombay developed a Smart material called Nithinol, which was used for the pipes/ducting in the wing. This material expands at low temperatures and contracts at high temperatures. It was validated.

The future of aviation in India.

India is a country where aviation is growing. Civil aviation growth in India is the highest in the world. IT industries are doing a lot of work in Aeronautics. They have become a back bone to all big companies and have started R & D laboratories. We have become the global suppliers. Honeywell, UTC etc have manufacturing facilities in India. There is tremendous growth. There are a lot of projects like MTA between Russia and India, unmanned aerial project, ADE. Airships are built in Agra. Compared to 1986, amount of work in Aeronautics today at HAL, govt. and private firms is 100 times more. Opportunities are many, so are the challenges. There is advanced fighter and unmanned aircraft programs. All the Aerospace MNCs have a set up here.

Kaveri engine is certainly an issue for Tejas but at a later stage when it is a success it can be incorporated into the aircraft.

My advice to the youngsters is that a formal degree is not enough. One should learn continuously and develop a feel for the subject. In this era of Information, to contribute, knowledge base should be increased continuously. We have pretty good engineers here. China is tenfold bigger. Our present government is pro-investment. So, definitely there are great opportunities.

Dr.M.S.Rajamurthy of National Aerospace Laboratories who worked under Dr. Kota Harinarayana has this to say about his association with him and the LCA program.

I was associated with the LCA program during the PDP phase between Sept.86-89 as a Deputy Project Director (DPD) in the Flight Mechanics and Controls group of LCA. Looking back, those three years has been a great period in my professional life. Those were the days of sceptics both within the team and outside. While LCA meant Latest Confusion in Aeronautics for some, for others it was Last Chance in Aeronautics. It was understandable that for more than two decades we had no aircraft design activity and technologies had grown leaps and bounds. In this environment, Dr.Kota inspired us and now LCA is flying.

At that time, our group was housed in the ADE campus. Dr.Kota was always positive. As the LCA Programme Director (PGD), he could call us to his office and enquire about the progress etc. But, Dr.Kota would come down to our campus, sit with us and discuss. Technically, Dr. Kota was keen on knowing the finer nuances of various disciplines and whenever he met the groups he would get into details. Whenever we met him, Dr. Kota would begin with – tell me Dear ..... These words brought us close to him and we would feel relaxed.

When, the new computing facility was setup at ADE – all groups worked late into the night. Our group was carrying out flight dynamics analysis. Many times, Dr.Kota returning from Delhi, on his way back home would first come to computing facility, meet us and enquire about the progress. His commitment and nice gesture inspired us to put extra enthusiasm and surge in to our work.

*Interview Team*

Dr. M.S. Rajamurthy, John N.J., Ison. N.



Painting by: Anuradha Rajamurthy

# KELLY JOHNSON:

## The man who could see “AIR”

John N.J., Lecturer  
Hindustan Aviation Academy

“That damn Swede, can actually see air” quipped Hall Hibbard, Kelly’s boss, which summed the abilities of Kelly Johnson the best.

Clarence Leonard “Kelly” Johnson is the designer of the world’s highest performance aircraft – the big bold “Blackbirds,” the SR-71 and the YF-12 – that were flying secretly at three times the speed of sound while other experts still were insisting that it was not feasible; and the graceful, glider like U-2, which can attain altitudes admitted to be “above 80,000 feet” writes Maggie Smith in the biography of Kelly Johnson named “Kelly: More than My Share of It All.”

Kelly Johnson was born to Peter Johnson and Christine Johnson in the remote mining town of Ishpeming, Michigan



on February 27, 1910. His parents were Swedish, from the city of Malmö,



county of Scania. Clarence Johnson was the seventh in a family of nine children. Kelly’s family was very poor and he had learnt very early in his life that he had to help out to help them earn what was needed. A particular story shows how humble a man of his stature was. An expert from his autobiography he says “to help with the finances, I spent one summer with an aunt in the farming community of Sands, less than 30 miles east and slightly south of Ishpeming. I earned my keep there, by doing things like raising the gear ratio to 20-to-one on the cream separator to make that lot easier to operate. I also earned \$3 picking wild blueberries. I got \$1.00 peck, which took a whole day to collect. When I went home at the end of the season, I handed the entire \$31 to my mother. There were tears in her eyes as she thanked me; she was so touched that I had not kept anything at all for myself. No contribution I have ever made since has made me feel happier. None has been more important to me.

Kelly Johnson went to the local library donated by Andrew Carnegie which Kelly Johnson credits as being the most important influence on his life, next to his father. It opened a whole new world to him. He discovered Tom Swift which he read not once but several times. Among his favourite reads were Tom Swift

Amelia Earhart sits on top of her Lockheed Electra plane with a group of Purdue University coeds



Earhart's ambitious mission was both unprecedented and dangerous. During the flight, she disappeared along with her navigator, Fred Noonan, somewhere over the south pacific.

After assignments as flight test engineer, stress analyst, aerodynamicist, and weight engineer, he became chief research engineer in 1938. In 1952, he was appointed chief engineer of Lockheed's Burbank, California, plant, which later became the Lockheed-California Company. In 1956 he became Vice President of Research and Development.

A number of factors contributed to Johnson's extraordinary career. He was a very talented designer and engineer. For instance, he could quickly and accurately estimate design characteristics such as mass, characteristics that usually were determined through long calculations. He was also ambitious and an excellent salesman, aggressively promoting ideas while also earning others' trust. In addition, he created teams and a work environment where creativity and productivity could flourish.

A few examples illustrate the influence of his work are the P-38 Lightning, a twin boomed aircraft which combined speed with unheard of advances at that time: the most innovative mission of its day was propelled by two supercharged engines and a potent mix of four 50 calibre machine guns and a 20 mm cannon.

and his Aeroplane, Tom Swift and his electric automobile, Tom Swift and his submarine. Tom Swift was a very highly skilled designer, engineer, pilot and operator of many kinds of locomotion and an adventurous young man. It became his goal to be just like Tom Swift.

A born engineer—"I knew I wanted to design airplanes since I was twelve years old," he once said. Johnson was 13 years old when he won a prize for his first aircraft design. He worked his way through Flint Central High School and graduated in 1928, then went to Flint Junior College, now known as Mott Community College, and finally to the University of Michigan in Ann Arbor, where he received a Master's Degree in Aeronautical Engineering.

At the University of Michigan, he conducted wind tunnel tests of Lockheed's proposed twin-engine Lockheed Model 10 Electra airliner. He found that the aircraft did not have adequate directional stability, but his professor felt it did and reported so to Lockheed. Upon completing his

master's degree in 1933, Johnson joined the Lockheed Company as a tool designer at a salary of \$83 a month. Shortly after starting at Lockheed, Johnson convinced Hall Hibbard, the chief engineer, that the Lockheed Model 10 Electra was unstable. Hibbard sent Johnson back to Michigan to conduct more tests. Johnson eventually made multiple changes to the wind tunnel model, including adding a "H" tail, to address the problem. Lockheed accepted Johnson's suggestions and the Model 10 went on to be a success. Lockheed Electra was the aircraft chosen by Amelia Earhart to circumnavigate the globe along a gruelling 29,000 mile route following the equator.





The P-38 was capable of climbing to 3,300 feet in a single minute and reaching 400 mph, 100 mph faster than any other fighter in the world. 10,000 of these fighters were built which were used extensively in World War II. Its versatility and ruggedness were legendary. It could sink a ship, strafed enemies on the ground, cripple tanks and shot down numerous fighters and bombers.

Kelly Johnson's team at Lockheed was not only keen on military projects, but they even ambitions to build the company's first large transport aircraft

which would carry more people farther and faster than ever before and the primary target was to achieve the same economically to broaden the acceptance of flying as an alternative to train, ship and automobile. This gave birth to Constellation – Connie for short- which was flown by airlines around the world, as well as the U.S military over 3 decades. The aircraft introduced new features previously unseen in passenger aircraft.

The Constellation offered for the first time hydraulically boosted power controls, aviation's equivalent to power

steering. It would be faster than any World War II fighters at 350 mph and it also used the award winning technology pioneered by Lockheed, a pressurized cabin for 44 passengers that allowed the plane to fly faster and above 90 percent of weather disturbances. The aircraft is remembered as an enduring symbol, the epitome of grace in propeller driven aircraft.

The P-80 Shooting Star which was America's first operational jet fighter. The F-104 Starfighter is a single-engine, supersonic interceptor aircraft originally developed for the United States Air Force (USAF). One of the Century Series of aircraft, it was operated by the air forces of more than a dozen nations from 1958 to 2004. A total of 2,578 Starfighters were produced.

The Lockheed U-2, nicknamed "Dragon Lady" was also developed under the leadership of Kelly Johnson at the skunk works unit of Lockheed. U-2 is a single-engine, ultra-high altitude reconnaissance aircraft operated by the United States Air Force (USAF) and previously flown by the Central Intelligence Agency (CIA). It provides day and night, very high-altitude (70,000 feet / 21,000 m), all-weather intelligence gathering. The U-2 has also been used for electronic sensor research, satellite calibration, and communications purposes. Early versions of the U-2 were involved in several events through the Cold War, being flown over the Soviet Union, China, Vietnam, and Cuba. In 1960 Gary Powers was shot down in a CIA U-2A over the Soviet Union by a surface to air missile. Another U-2 piloted by Major Rudolf Anderson, Jr. was lost in a similar fashion in the Cuban Missile Crisis of 1962. The U-2 is one of a handful of aircraft types to have served the USAF for over 50 years.



Johnson also led the development of the SR-71 Blackbird family of aircraft. Through a number of significant innovations, Johnson's team was able to create an aircraft that flew so high and fast that it could neither be intercepted nor shot down. No other jet airplane has matched the Blackbird's performance. As Johnson said: "The idea of attaining and staying at Mach 3.2 (more than three times the speed of sound) over long flights was the toughest job the Skunk Works ever had and the most difficult of my career.

Aircraft operating at those speeds would require development of special fuels, structural materials, manufacturing tools and techniques, hydraulic fluid, fuel tank sealants, paints, plastics, wiring, and connecting plugs. Everything about the aircraft had to be invented. The anticipated temperatures on the aircrafts leading edges exceeded 1000 Fahrenheit, while temperatures outside the cockpit window would be -60 degrees Fahrenheit. Hours were spent by the skunk works team tackling the problem of dissipating the heat across the entire airframe. The answer to the relatively complex problem was solved by a simple lesson taught in high school physics classes. Black paint both emits and absorbs heat. As a result the entire aircraft was painted black and soon earned its name "BlackBird."

But it all came together. Technologically ahead of their time, Johnson's Blackbirds were in the skies in the early 1960s: the A-12's first flight was in 1962; the YF-12A in 1963; and the SR-71 in 1964. With in-flight refuelling, the SR-71 attained global range. SR-71 Blackbirds went on in the 1970s to chalk up records for speed (2,193 mph), altitude (85,069 feet), a trans-Atlantic mark of one hour, fifty-four minutes, on a 3,470-mile flight from New York



to London; and a world speed record of three hours, forty-seven minutes on a 5,463-mile flight from London to Los Angeles. In March 1990, the year the Air Force retired the Blackbirds from service, an SR-71 streaked across the United States in a record sixty-eight minutes on the 2,400-mile flight coast to coast. When Clarence L. (Kelly) Johnson died in 1990, his SR-71 Blackbird, which first flew almost thirty years before, was still the world's fastest and highest-flying aircraft.

A number of factors contributed to Johnson's extraordinary career. He was a very talented designer and engineer. For instance, he could quickly and accurately estimate design characteristics such as mass, characteristics that usually were determined through long calculations. He was also ambitious and an excellent salesman, aggressively promoting ideas while also earning others' trust. In addition, he created teams and a work environment where creativity and productivity could flourish.



Kelly Johnson and Francis Gary Powers talk shop with an early U-2 behind them

A photograph showing a technician working inside the fuselage of an aircraft. The technician is silhouetted against a bright light source, possibly a window or a work light, which illuminates the interior structure of the plane. The technician is reaching up towards the ceiling of the fuselage, possibly inspecting or working on a component. The image is in a warm, golden-brown color palette.

# AIRCRAFT MAINTENANCE MANUALS

In the world of aviation and its versatility, safety of flight couldn't be more important. There are as many people flying to different destinations as they are driving. Safe operations, as well as good maintenance practices, are the two keys that keep flying safer than driving.

This article will focus on maintenance. Good maintenance starts with a good plan and a good plan will include good maintenance scheduling. All aircraft experience external and internal forces that most passengers have no knowledge of. Therefore, scheduling maintenance inspections are needed to help prevent these forces from having a negative impact on an aircraft's ability to take off, fly, and land safely. Aircraft manufacturers have designed and tested their airframes, power plants, and components to their extreme limits and developed maintenance programs and procedures based on data collected through the testing.

Operators can use the maintenance planning schedules that the manufacturers have developed or they can develop their own planning schedules based upon data collected through their own experiences.

The practice of maintenance, on the other hand, is a whole different topic. As the aviation industry grew into what we have today, there needed to be some sense of standardization. For this reason, manufacturers developed a series of manuals to assist technicians in maintaining aircraft, engines, and associated components.

Let's explore the manuals. Aircraft Maintenance Manuals (AMM), Structural Repair Manuals (SRM), Engine Shop Manuals (ESM), Illustrated Parts Catalog (IPC), Electrical Standard Practices Manuals (ESPM), Component Maintenance Manuals (CMM), Standard Overhaul Practices Manuals (SOPM), Aircraft Troubleshooting Manuals (ATM), and the list seems to go on and on. Included with the manufacturer's manuals, many operators have specialized engineering documents that pertain to a specific aircraft or appliance. Although the engineering documents will use the ATA system for tracking, they don't use it as extensively as the manufacturer's maintenance manuals. However, even though there are different manuals and engineering documents, they all follow a basic ATA code system that makes

them easier to navigate, no matter what nation an aircraft is flagged in.

The standard numbering system was published by the Air Transport Association on June 1, 1956. ATA 100 Chapter numbers were a common referencing standard for all commercial aircraft documentation. While the ATA 100 numbering system has been superseded, it continues to be widely used today, especially in older documentation for general aviation aircraft and printed manuals.

In today's world of technologies, a newer referencing standard was needed to cover the new systems and technologies being incorporated into aircraft design. The Joint Aircraft System/Component JASC Code Table is a modified version of the Air Transport Association of America (ATA), Specification 100 code. It was developed by the FAA's Regulatory Support Division. This code table is constructed by using the new JASC code four digit formats, along with an abbreviated code title. The abbreviated titles have been modified in some cases to clarify the intended use of the accompanying code. The final version of the JASC/ATA 100 code was

released by the FAA in 1999.

In 2000, the ATA Technical Information and Communications Committee (TICC) developed a new consolidated specification for the commercial aviation industry, ATA iSpec 2200. It includes an industry-wide approach for aircraft system numbering, as well as formatting and data content standards for documentation output. The main objectives of the new specification are to minimize cost and effort expended by operators and manufacturers, improve information quality and timeliness, and facilitate manufacturers' delivery of data that meet airline operational needs. More recently, the international aviation community developed the S1000D standard, an XML specification for preparing, managing, and using equipment maintenance and operations information.

ATA Chapters have four main categories: Aircraft General, Airframe Systems, Structure, and Power Plant. Within these four categories are subcategories that are given a number associated to them. For example:

**Aircraft General contains:** Time limits/maintenance checks - 05, Dimensions and Areas - 06, Lifting and Shoring - 07, Leveling & Weighing - 08, Towing and Taxing -09, Parking and Mooring -10, Placards & Markings - 11, and Servicing -12.

**Airframe Systems contains:** Standard Practices -20, Air Conditioning -21, Auto Flight - 22, Communications -23, Electrical Power -24, Equipment/Furnishing -25, Fire Protection -26, Flight Controls -27, Fuel -28, Hydraulic Power -29, Ice & Rain Protection -30, Indication &Recording -31, Landing Gear -32, Lights -33, Navigation -34, Oxygen -35, Pneumatic -36, Vacuum -37, Waste/Water -38, Central Maintenance System -45, and Airborne Auxiliary Power -49.

**Structure contains:** Standard Practices



-51, Doors -52, Fuselage -53, Nacelles/ Pylons -54, Stabilizers -55, Windows -56, Wings - 57, Propellers -61, Main Rotor -62, Main Rotor Drive -63, Tail Rotor -64, Tail Rotor Drive -65, and Rotorcraft Flight Controls -67.

**Power Plant contains:** Standard Practices Engine - 70, Power Plant -71, Engine -72, Engine Fuel & Control -73, Ignition -74, Air - 75, Engine Controls -76, Engine Indicating -77, Exhaust -78, Oil -79, and Starting -80.

Aircraft will continue to evolve, as will the manuals required to maintain them. New procedures, materials, and designs will continue to test the limits of flight and its limits. With this, a new breed of maintenance technician will be needed, as well as, up to date referencing systems. No matter what manual or referencing system is used, the Introduction section of the manual is filled with information on the best way to navigate them. The first line of training on any aircraft or system for a technician should start with the Introduction section of the manuals. This basic knowledge is essential in any maintenance technicians' ability to navigate their way through the library

of information needed to maintain an aircraft or appliance.



**Charles Bridgeforth**

Charles Bridgeforth started his aviation career in 1980, by entering into the U.S. Air Force. There he spent 9 years working on numerous different aircraft. In 1989, he separated from the Air Force and entered Colorado Aero Tech, School of Aviation Technology. There he graduated with Honors and began his journey in the commercial aviation industry. Over the last 34 years, these journeys include travels to Alaska, China, Japan, Philippines, Korea, England, Argentina, and a great many other places in between. He has worked in positions as a maintenance technician, QC Inspector, and Chief Inspector for numerous Part 121 Air Carriers as well as Part 145 Repair Stations. He continues working as a QC Inspector to date.



Mr. D R Subramanyam  
Director, SLN Technologies Pvt. Ltd.

# SLN TECHNOLOGIES

## SERVICE LEADERSHIP INNOVATION

SLN Technologies is an Electronic Systems Design and Manufacturing company offering rugged and high reliability embedded systems for Aerospace and Defence Industry. SLN offers design, development, testing, qualification, manufacturing and maintenance solutions. SLN specializes in Embedded System Solutions, Board Design Solutions, Embedded Software Solutions, FPGA Design and Development, IV&V and Re-Engineering of legacy Embedded Systems. SLN offers both build to specifications and build to Print to its customers.

SLN Product Domains in Aerospace and Defence include

- Avionics LRUs
- Automated Test Equipment
- Integration Rigs
- Ground Support Equipment (I-level and O-level testers)
- Antenna Control Systems (for Radar and SATCOM antenna)

- Instrumentation
- High Reliable Electronic Modules

SLN has proven expertise in electronic hardware interfaces namely Analog, Discrete, RS232/422/485, Ethernet, USB, SPIL, CCDL, MIL1553B, ARINC429, ARINC717, Audio, Video and bus Architectures namely PCI, cPCI, VME, VME64X, VPX, PXI, PMC and Custom Bus Architecture. SLN is proficient in Aerospace standards namely DO-254 for development of hardware, DO-178B for development of Software and DO-160E for Conducting Qualifications tests on Embedded Systems.

SLN is an ISO 9001:2008 certified company and in the process of implementing AS9100C standard in the company. SLN is a CEMILAC certified design house for designing Airworthy systems. SLN is a recognised "In-house R&D unit" by Department of Scientific and Industrial Research (DSIR), DST, Govt. of INDIA.

SLN has been awarded SIATI Award 2014 for "Excellence in Aerospace Indigenisation". SLN was awarded "National Award-2008" a Special recognition award for Research and Development by Ministry of MSME, Govt. of India. SLN was awarded 1st prize for "Excellence in Electronics in Research and Development for the year 2007-2008" by ELCINA-DUN & BRAD STREET. SLN was awarded Outstanding Performance for "Excellence in Electronics Research and Development for the year 2009-2010" by ELCINA-EFY.

SLN has built high reliability embedded systems which are operating in mission critical applications. Some of the major products are:

1. Antenna Control Servo System for 32 mtr. Deep Space Network Antenna used in Chandrayaan-1 (Indian Moon mission) and Mangalyaan (Indian Mars orbital mission) missions of ISRO.
2. Solid State Flight Data Recorder (SSFDR) HW for Su-30 MKI.
3. Air Data Computer (ADC) HW for LCA
4. Solid State Memory Module for AN32
5. Flight Test Instrumentation HW for LCA
6. Antenna Control System for 3D Radars
7. Antenna Control System for Stabilized platform on Ship.



Solid State Flight Data Recorder System for Su-30 MKI



Integration Rig for Display and Mission Computer

8. Main Gun Control Box to Arjun Main Battle Tank.
9. ATEs for SSFDR, ADC, LADC and Flight Test Instrumentation etc.
10. Integration Rig for Display Mission Computer (DMC) for LCH and DARIN III MC

SLN has focus on providing solutions in the Cockpit Voice and Flight Data Recorders (CVFDR), Antenna control Systems (ACS), Solid State Digital Video Recorders (SSDVR) and Health and Usage Monitoring Systems (HUMS) domains.

SLN has designed, developed and qualified the solid state flight data recorder (SSFDR) for Su-30 MKI. SSFDR performs the function of sampling the aircraft sensors data and Cockpit voice and record the voice and data for analysis of the sortie later or in case of a crash. SLN has developed the SSFDR HW system from interface specification till getting the flight approval. The customer has a very good appreciation for the support SLN gave in the product development of the SSFDR system. SLN has invested in building expertise and delivery models for the flight data recorder technology. SLN is presently one of the leading indigenous manufacturers for flight data recorders in INDIA.

SLN with the expertise in Flight data recorders got the opportunity to develop the CVFDR HW for the Light Utility Helicopter (LUH). The CVFDR is a leaner system because of the nature

of Helicopter systems. SLN had the expertise of, the solution for fixed wing aircraft, some critical factors like weight and power consumption were critical factors in Rotary wing aircraft. SLN has successfully developed the CVFDR for the LUH platform. Now SLN has the capability to supply CVFDRs for both fixed wing and rotary wing aircraft.

SLN is now building SSDVR. SLN has also planned in the near future to develop products for Standby Engine Displays, HUMS etc.

SLN is also strong in building Automated Test Equipment (ATE). Due to SLN strength in building Embedded Systems, SLN has a thorough understanding of the testing requirements for embedded systems. SLN has the expertise to build ATEs for Embedded systems, sub-systems and electronic modules. SLN has good expertise in building ATEs with

National Instruments PXI hardware with LABVIEW based software. SLN has also built Rugged ATE and compact ATE based on OPEN bus architectures Viz. PCI, cPCI and VME.

SLN has a very strong expertise in Antenna Control Systems (ACS) for radar and satcom antenna applications. SLN has developed and deployed 7 types of ACS for Radar antenna. All of these systems are mission critical in nature and operating in varied environmental conditions. These ACS are of single axis or two axis control systems performing antenna deployment and platform stabilization. SLN has also expertise in three axis control systems for SATCOM application. The three axis are Azimuth, Elevation and Polarization. SLN has built ACS for Pointing and Tracking Applications. Some of the prominent features are step track algorithms and closed loop control laws. SLN is a leading indigenous manufacturer for ACS for SATCOM applications.

SLN is one of the elite leading Electronic Systems Design and Manufacturing Company in INDIA for Aerospace and Defence industry providing state-of-the-art indigenous solutions equivalent to leading Global OEMs. SLN is continuing to invest in expertise and infrastructure for indigenous manufacture of high reliable embedded systems for mission critical applications. Please visit the website [www.slntech.com](http://www.slntech.com) for more details.



Mr. D R Subramanyam with Hon'ble. Defence Minister Mr. Manohar Parikar and Hon'ble Union Minister for Chemicals and Fertilizers Mr. H N Ananth Kumar at Aerospace Exhibition

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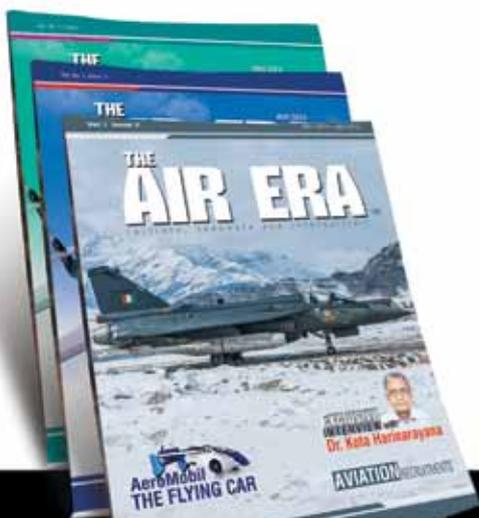
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## BAROLA AERO SPORTS

Barola Aero India's first ISO 9001:2008 certified company in the field of UAV and Aero Modelling Training. The Electric Specialist whose primary objective has been "affordable" UAV training and Aero modelling". Have emerged as Leaders in providing services and "Practical Engineering" by training over **12,000 students** from its inception in the year 2010. It has made a mark in training young engineers and transforming them to **Technopreneur**. As part of **R&D** have designed and developed **application prototypes** on the following

**UN-MANNED AERIAL VEHICLE  
AND SYSTEMS**

**UNDERWATER VEHICLES**

**HYDROGEN FUEL CELLS AND  
RENEWABLE ENERGY**

**SENSORS**



## ACCOLADES

INDIA'S FIRST ISO 9001:2008 CERTIFIED UAV AND AERO MODELING TRAINING COMPANY.

- MOU WITH NDRF (NATIONAL DESIGN AND RESEARCH FORUM, INSTITUTE OF ENGINEERS INDIA)
- MOU WITH ESCI (ENGINEERING STAFF COLLEGE OF INDIA, INSTITUTE OF ENGINEERS.
- AWARDED **ENTREPRENEUR OF THE YEAR 2014** FOR MANUFACTURING BUSINESS-ENGINEERING
- RECOGNIZED BY **CII (CONFEDERATION OF INDIAN INDUSTRIES)** for being selected for the Final Jury at CII Industrial Innovation Awards 2014.
- AWARDED FOR DESIGNING THE **BEST BEGINNERS GLIDER BY SAE INDIA** (AN AFFILIATE OF SAE USA) FOR YEAR 2012 & 2013
- TRAINED SAE SOUTHERN SECTION FINALISTS FOR THREE CONSECUTIVE YEAR **2012, 2013 & 2014**
- Barola Aero Sports among **MAV experts in India** published by NDRF, IEI
- SET UP 11 AERO CLUBS ACROSS THE COUNTRY
- TRAINED OVER **12000 STUDENTS** AND HAVE DESIGNED & FABRICATED MORE THAN **500** FINAL YEAR ENGINEERING CONCEPT PROJECTS
- ONE FINAL YEAR PROJECT DESIGN BEING PATENTED IN GERMANY
- ONE FINAL YEAR PROJECT WAS SELECTED FOR GLOBAL AIR BUS FINALS HELD AT FRANCE.
- ONLY TRAINING ORGANIZATION TO HAVE BEEN SHORT LISTED ALONG WITH 14 FINALISTS NATIONALLY FOR **MICAV 2013** A NATIONAL COMPETITION TO DESIGN INDIGENOUS MAV'S CONDUCTED BY NAL/ DRDO.



### CONTACT BAROLA AERO SPORTS FOR THE FOLLOWING WORKSHOPS AND PROJECTS

UAV	CFD
HYDROGEN FUEL CELL AND RENEWABLE ENERGY	CATIA
UNDER-WATER	APPLICATION BASED UAV AND AERO-MODELLING

For more  
Details  
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## Constructing Dreams into Reality- DR K.C SAMUEL

### The Journey to Build an Aviation University

Aviation has special mystery attached to it & it is universal childhood dream of earning wings. Aviation has & had always been a better paid, more attractive & glamorous job in popular imagination. The growth had been phenomenal with new technology evolving everyday & aircraft becoming bigger & bigger with popular demand of flying as a status & also for fast communication. Thus there had been constant demand to train the Pilots & Aircraft Engineers. The no. of training establishments had been few. I never wanted to be tied down with a job. My inner voice created a drive in me to be an entrepreneur in the field of aviation. Therefore, after completion of my Aeronautical Engineering and flying, I planned to start on my own instead of joining an airline or any other firm. However, I decided to understand

the requirement of the students, to do this better. I taught the subjects in an aviation school in Chennai for 3 years and made my decision. I moved to Bangalore as Bangalore is the Aviation hub. I established the First Avionics School in 1986.

Though it is so difficult even now to make investment and to start a new venture, my plan for a complete aviation academy has always kept me moving ahead with this plan. Those days Avionics License was not there in DGCA and only Radio License (ARME) was the only option and got the approval by DGCA in 1986. Mr.K.B.Ganeshan, the then Acting D.G discouraged me from the venture because of lack of awareness, the poor response and the viability of the project. But my decision to go ahead, was encouraged by him. Then the biggest task was obtaining the equipments for the labs. Importing

these equipments were too expensive and importing these equipments was allowed only for commercial purposes. The only option left was to go ahead and approach the public sector enterprise like HAL or IA/AI. They refused to part with any of these because of their policy to only auction the items to scrap dealers.

This made us to approach scrap dealers who auctioned the grounded /scraped aviation equipments and aircrafts from IAF and Airlines. Initially we had to go to a scrap yard and select these items in Agra, brought these to Bangalore and made it all serviceable to start the 1st Private Avionics School in India.

Mr.V.N.Natarajan a retired Engineering Manager, IA, name I always remember and admire, because of his devoted work/service to this Institution. He made all the equipments serviceable and we had the 1st batch of 5 students

to start with the Avionics Academy in 1986. By 1992 the Avionic stream of aircraft Maintenance Engineers was progressing well with the DGCA approval and the Academy had earned the reputation of being one amongst the top few institutions with full capacity. This brought in demand for training of Mechanical stream AME trainees, thus the training in this stream was started in 1992. Today it conducts Aircraft Maintenance Engineers License in both mechanical and avionics streams as well as heavy aircraft rating with the approval of Directorate General of Civil Aviation, Govt of India. The Academy now has an identity as Hindustan Aviation Academy. The students are placed not only in the local Airlines but International Airlines. The Singapore Airlines had evaluated the Aircraft Maintenance Engineering students and selected 80 students for training at their establishment in Singapore. These students after training are working in their Airline locations all over the World. My vision to have an Academy where comprehensive training is provided not only in engineering subjects but flying and Aviation Management, motivated me to start a flying school in private

sector. This also was delayed indefinitely due to the bureaucratic delays and stringent import rules and regulations. In 1994, June we established the Academy in the name of Bangalore Aeronautics Technical Services and operated for 6 months at Coimbatore and had to close because of the two and a half years of struggle to take off drained out all the finances and we were forced thereafter to transfer the enrolled candidates to other flying academies.

Meanwhile our Electronic Academy polytechnic made good progress in the field of Diploma in Engineering and we established the Aeronautical Engineering branch as a new course along with various branches of engineering existing under DTE in the state of Karnataka. All our students who completed their programmes are doing extremely well.

The Audi group identified Hindustan Electronics Academy for training of Automobile Engineering Faculty and students for their servicing centres in the country, this is the only training facility established in India. The training aggregates for Engine, transmission system and the car assembly were

directly brought from Germany to set up a state of the art training centre.

In 2009 the IGNOU approached us for conducting B Tech in Aerospace Engineering, having learnt about the Academy's standing in field of Aviation. It approved the Academy initially with intake of 60 students which was enhanced to 120 in 2010 after being satisfied with the professional manner in which the programme was being run. Another Central University, CUK took interest in the professionalism of the Academy and approved B Tech (AE) programme in 2013. Presently the programme is in progress from both the Central Universities.

The Academy is also affiliated to the Bangalore University for other diversified programmes of BBM and B.Com

Considering the specialization in Aviation and due to students and parents appreciation of the reputation of the Academy and my vision, a full fledged Engineering College with many more branches of Engineering is under construction at Hoskote and is expected to be functional by 2016. This is likely to serve as a stepping stone for establishing an Aviation University.





# ACAELO V1

## Unlearning to Learn, a Journey to Realize the Joy of Conquering the Air

From Otto Lillenthal's perfect glider in the 19th century to the Wright Brother's 12 second sustained flight in 1903, Sir Frank Whittle's Jet engine in 1903, more than three centuries of innovation and ingenuity for inspiration.

We, students of Hindustan Electronics Academy, Polytechnic have been compelled to design and build a

microlight aircraft from scratch. Basically a microlight is a small light weight aircraft capable of taking flight. Regardless of its size, aircraft building is an expensive hobby, if not done under proper financing.

With the budget and resources, we have constantly been reminded that not only our project would prove to be difficult

but it is close to impossible. But making the impossible possible is in human nature.

The first two months was filled up by constant planning and structure design. Limiting the possibilities, while keeping the basic concepts in mind and narrowing the design into what we think is best suited considering the cost,

material and fabrication limitations were done. With a sketch drawn up and the plan along with the schedule set, our work was cut out for us. Slowly and with enthusiasm and we set out to begin our first try at the skies.

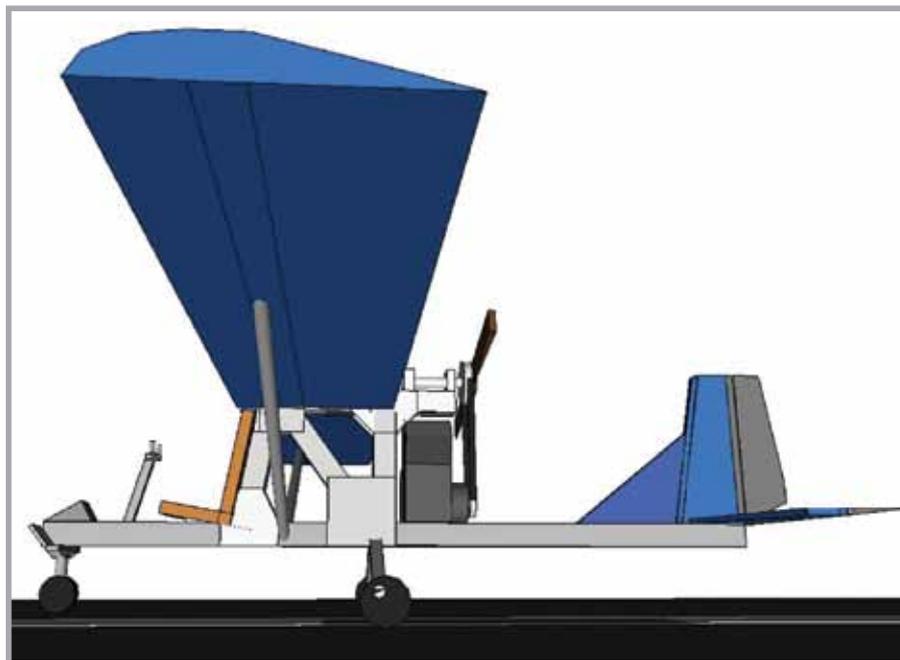
A microlight, single seater with a pusher configuration, single propeller, powered by a single cylinder motorcycle engine with 17.2 bhp at 8500 rpm and 15.7 Nm torque was the



goal. This was our basic structure and propulsion systems. We had created a make shift workshop close to the factory where our fabrication was being done.

Initially we started out making the basic structure out of aero aluminum and securing it with brackets and rivets to maintain the microlight weight as per regulation's set by directorate general of civil aviation [DGCA]. Then we moved on to the control surfaces, using foam and coroplast to reinforce and cover our 6 meter wing structure. These control surfaces are push pull cable and rod configuration which are collectively controlled using a yoke for three axis control. Most of the materials used were easily available. All the parts and components had come together.

Those quick days and endless nights we spent working together were finally reaching the end and it had reaped such a ripe fruit, an actual microlight aircraft. As we looked at it, we knew it belongs in the sky. We christened it as "ACAELO"



which closely translated to "part of the sky" in Latin.

With the microlight close to its purpose, the only dream is for it to take on the sky. If every book has an end then taking flight would be final chapter.

**Team ACAELO V1:**

Daniel Paul, Rahul Raj, Biradar Kiran, Nischint, Vijay Ragevendra, Adith Sagar, Sachin Sharma, Sachin Urs  
Project Guide: John N.J.

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Agragami Applied Aeronautics is the perfect place for the students of all kinds of diversity who really want to pursue a keen knowledge about flying vehicles and unmanned systems. We really respect those students who have the potential to do something for the society and country through the advancement of science and technology. We invite them to do work with us and let's promote the technology through inspiration and innovation.

Apart from these the courses and facilities we provide will give you an exposure to get into various Aerospace companies in India as well as in abroad. All software companies in India are now putting their hands into aerospace field, which is really creating lots of job opportunity for the students of today's generation. If you really have the motivation inside yourself to do work for Aerospace Industries then come to Agragami Applied Aeronautics which will make you ready to face the real world situations.



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**Agragami Applied Aeronautics**

is a branch of Agragami Group of Institutions. It is a separate department for providing Aerospace services and its solutions. This department is fully dedicated to the students who are interested in UAVs and small flying objects including fixed wing aircrafts and multi-copters. It is the one and only RC Institute set time in India which provides the students on campus flying training, workshop and Internships facilities. Students can come, stay and pursue their knowledge in various programs from well experienced professionals.



### Aerial Photography

We provide an unique experience to the customers to obtain high quality imaging of terrains, crop, water land and forestry estimation etc.



### Air shows

We have brought an opportunity for you to have a real flight show in front of your sight. You will get an actual combat field experience along with lots of fun and starts.



### Internship & Training

- Fixed Wing UAV/MAV
- Rotary Wing UAV/MAV
- UAV Propulsion Systems



### Workshop

- RC Aircraft
- RC Quad copter
- Glider



### Flying Training

- Fixed wing (Electric / Engine plane)
- Rotorcraft (Quad copter/Tri copter/ Hexa Copter)
- FPV flying



### R&D:

Agragami Applied Aeronautics has its own facility and establishment for doing research and development of high grade UAVs which are capable of accomplishing real world goals and mission.

Agragami Applied Aeronautics aims to create a platform for the students and youngsters to develop unmanned systems that can be used for civilian as well as defence purpose.

What we Offer

Name of Course	No. of students in one team	Duration	Fee structure (per team in Indian Rupees)	
Workshops	RC Aircraft	4	2 Days	4000/-
	RC Quad copter	4	3 days	8000/-
	Glider	4	1 days	3000/-
Internship & Training	Fixed Wing UAV	3	7 days	15000/-
	Rotary Wing UAV	3	7 days	18000/-
	UAV Propulsion Systems	3	7 days	4000/-
Flying Training	Fixed Wing	1	6 - 10 days	15000/-
	Rotary Wing	1	6 - 7 days	18000/-
	FPV flying	1	15 - 18 days	30000/-

# HIGH PERFORMANCE RUGGED SYSTEMS FOR MISSION CRITICAL APPLICATIONS



Solid State Flight Data Recorder for Su-30MKI



Software Integration Rig for Display and Mission Computer



Antenna Control System for 3D Tactical Control Radar



VME64X Single Board Computer



Antenna control System for 1.8m Mobile Communication Unit



Antenna Control Servo System for 32m Deep Space Network Antenna of Chandrayaan-1 Mission

## Design, Development and Manufacturing of Indigenous

- Airborne Electronic Systems (LRU)
- Ground Support Systems (ATE, SIR, 'I' level, 'O' level)
- Antenna Control Systems (Radar, Communication Antenna)
- Data Milking & Analysis Tools

ISO 9001:2008 Certified Company

CEMILAC Approved Design House

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PASSION TO INNOVATE

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Gandhi Institute of Technology and Management, known as GITAM University, established u/s 3 of the UGC Act, 1956, is one of India's leading universities having 34 years of track record in teaching and research of global standards.

The University is located in three picturesque campuses at Visakhapatnam, Hyderabad and Bengaluru. With a multi disciplinary approach, the University offers 118 programs at UG, PG and Doctoral levels in Technology, Science, Pharmacy, Management, International Business, Architecture and Law.

The University is the first choice of the students from almost all the States in the country.

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