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Lift Off

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The Curious Case of MH370

by Apurv Tiwari

It was business as usual the night of 7th March, 2014 at the Kuala Lumpur International Airport in Malaysia. The hustle and bustle of commuters eager to be on their way felt part of the everyday routine. Among the planes scheduled for departure was the Malaysian Airlines flight 370 (MH370), one of the two daily flights from Kuala Lumpur to Beijing.

With 227 passengers, 12 crew members, 14,296 kg of cargo and 49,100 kg of fuel which allowed an endurance of 7 hours and 31 mins, the plane was destined on a journey of 5 hours and 34 minutes; but flew far more after mysteriously disappearing off the radar.

Amongst the initial public shock and media frenzy, the InterPol found out that two of the passengers were on fake passports, fuelling the already prevalent speculations of a hijack. However, after interviewing the relatives and doing a background check on the passengers, it turned out that not only the two suspicious passengers, but nobody among the persons on board had any terrorist connections at all.

The most intriguing fact about the incident was the lack of a distress signal from the aircraft. A pilot usually has numerous ways to send out an emergency signal which includes sending off a different frequency signal even after the flight transponder has been switched off. A hijacker wouldn't be able to decipher this act unless he/she was a very experienced pilot himself/herself. A lack of an emergency signal pointed to another angle to this tragedy.

The plane took off at 12:42 MYT on its predefined flight path on level 180 (18,000 feet). The pilots and the Kuala Lumpur ATC were in regular contact till 01:19 MYT. At that point, the aircraft reached the end of Malaysian airspace (at a navigational waypoint called IGARI) and was entering the Vietnamese airspace. This is the last bit of conversation between the Malaysian ATC and the plane – the last it ever had with anyone.

ATC – Malaysian three seven zero, contact Ho Chi Minh one two zero decimal nine. Good night.
Pilot – Good night. Malaysian three seven zero.

Two minutes after this, the plane vanished from the Malaysian radars as it entered the Vietnamese airspace, but the Vietnamese radars never received a signal from the plane. The flight transponder had been switched off.

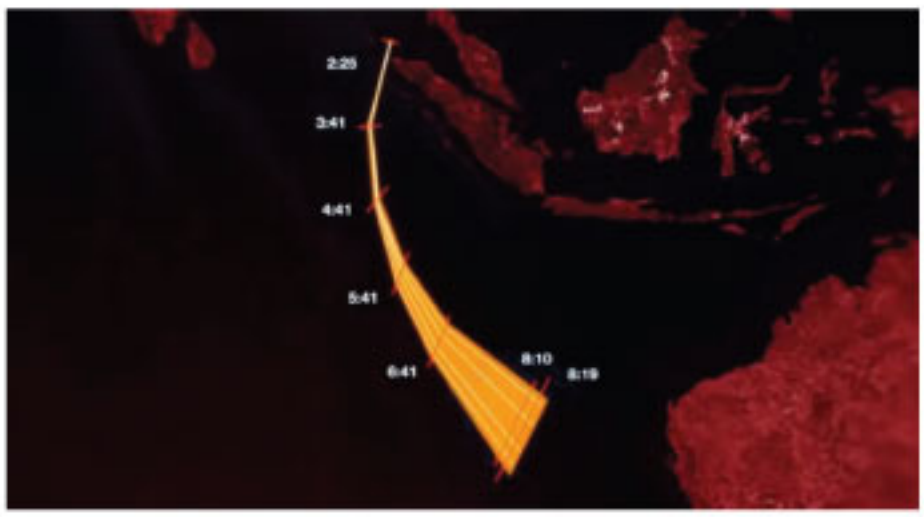
The ACARS (Aircraft Communication Addressing and Reporting System) is a digital datalink system between aircraft and ground stations via satellite. The satellites however don't get any knowledge of the plane's location.

At 22:51, even this ACARS system was shut down. The intriguing thing is that the ACARS system is very difficult to turn off manually. One would need to have in-depth knowledge of the working of the electronic systems of a flight to turn it off. The only explanation was a fire on board. The cargo section of the plane carried 221 kg of Lithium batteries, which are easily inflammable. Hence, the possibility arose that the plane would have crashed in the Gulf of Thailand. But 3 days later, on 11th March, the Malaysian military released their military radar data, which made a huge revelation.

This is the route the plane followed as per Malaysian military radar data. The military found an unidentifiable object in their airspace and the timing coordinated exactly with the missing airplane. The plane had made a sharp turn at IGARI towards the left and continued forward. One might have presumed that it was trying to reach a nearby airport due to an on-board fire, but it made another turn later to the right, overruling the possibility. This data refueled the hijacking theories.

The final piece of the puzzle was yet to fall in place. Boeing 777 is a highly secure jet. It has many safety provisions in place and is considered as one of the safest planes for civil aviation. There are many systems which can't be hindered even through human intervention. Even when the ACARS system was off, there was another subsystem wherein the flight's satellite communication system communicated with satellites once every hour. The geostationary satellite for the Indian Ocean Region (IOR) had established contact with the plane. Such a contact was insufficient to exactly predict the plane's location, but researchers from all over the world studied this data and the following map was formed. After 8:19, the plane lost contact with the satellite. At IGARI, the flight data had specified 41,500 kg of fuel, enough to last it for 7 hours on cruise mode. This had set the crash time to approximately 8:19 MYT.

All these facts led to a debatable theory – the suicide pilot theory. Over the last 42 years, 7 incidents have taken place where the pilots themselves deliberately crashed their planes.



The Curious Case of MH370

The theory goes as follows- The captain might have ordered the co-pilot to leave the cockpit for some reason. Interestingly, there is no way to enter a locked cockpit in Boeing 777- no way could one force their way through. There is no chance to contact the ground anyway from outside the cockpit. The pilot might have changed the plane's direction in such a manner that no one would be able to find it after the crash. The next and final step would be to depressurize the cabin. This would lead to a planned crash. This would also explain the long undisturbed cruise of the flight from 2:25 to 8:19.

But this theory has a flaw too. The pilot had no reason to plan such a thing. Although the police found a flight simulator at his home which simulated flight in the Sumatran region and IOR – a route on which the pilot was practicing but had never taken and also wasn't expected to take in the future as well, there was no financial or psychological reason for a trained pilot with 23 years of flying experience and no nefarious connections to perform such a deed. Also, why would a suicidal pilot care to circumvent the military radar of Indonesia and follow a very odd route to do the same?

The ATSB has taken the responsibility for searching the debris of the missing plane on request of the Malaysian government. The search is still on and the ATSB posts operational updates every week on its official website.

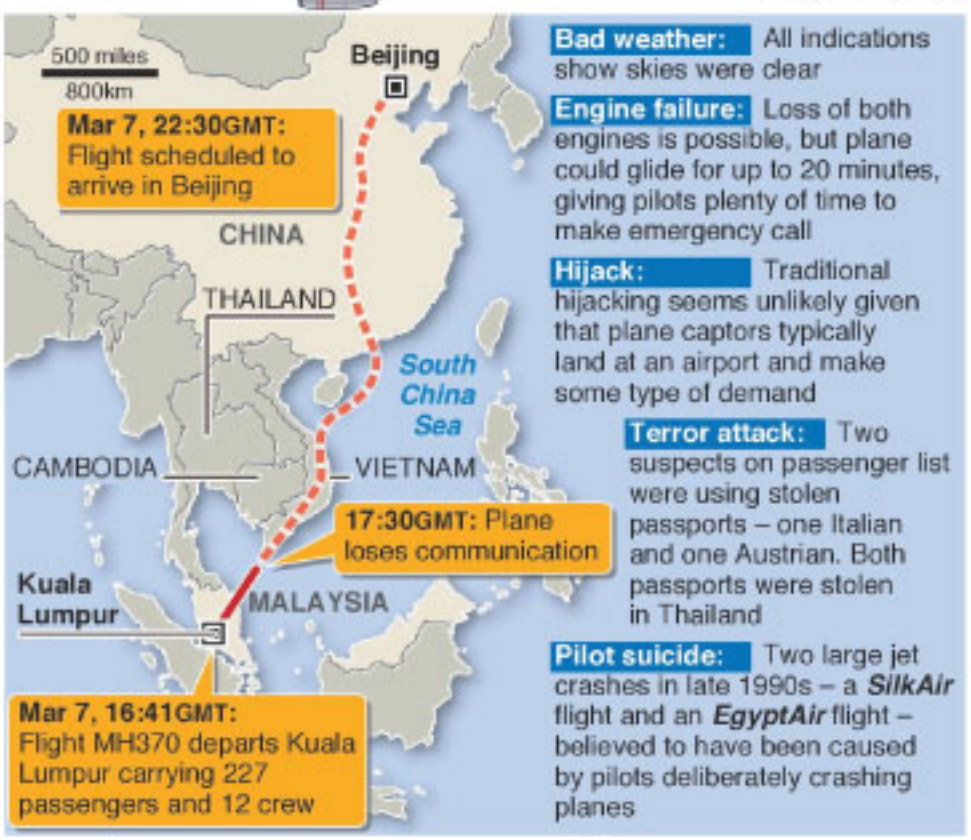
The incident shocked the aviation committee at large which suggested improvements to the existing mechanisms, ensuring that a repeat of this case does not happen again:

1. Aircraft tracking rules are being redefined now. Inmarsat has proposed contacting each flight fitted with their satellite communicator (that's 99% of flights) every 15 minutes.
2. The International Civil Aviation Organization has changed standards to the effect that every aircraft will have to report its position every 15 minutes while flying above oceans. Also, planes manufactured after 2021 will send data every minute during distress. Automatic distress standards are also undergoing scrutiny.
3. There was a call for automatic transponders but aviation companies as well as pilots opposed it due to flexibility issues. Also, during a fire, the transponder needs to be cut off to suppress the spreading of fire. The manufacturers now plan to install circuit breakers with an automatic transponder, but history has it that automatic transponders have always been subject to pilot resistance.
4. CVR records voices only for two hours, after which it starts overwriting existing data. If the suicide theory is to be believed, the events leading to the crash happened hours before the crash. So the CVR would be useless even if found in such a case. The new standard has been set to 25 hours from 2018. Also from 2020, the aircrafts would need to have systems to transmit CVR and FDR data to ground before a crash. Or else these systems should be able to be ejected and should also be buoyant.

Possible causes for the loss of flight MH370

Catastrophic structural failure: Most aircraft are made of aluminium which is susceptible to corrosion over time. **Given plane's safety record – one fatal accident prior to loss of flight MH370 – experts suggest that failure of airframe, or plane's Rolls-Royce Trent 800 engines, is unlikely**

Boeing 777-200



The FDR (Flight Data Recorder) and the CVR (Cockpit Voice Recorder) couldn't be recovered.

The search operation was the biggest in entire aviation history, with the search area millions of square kilometers under the Indian Ocean.

Agile ocean currents made this search more difficult. The discoveries began with a flaperon (part of the wing) on the French owned Reunion islands in July 2015. After that, a lot of flight debris– some recognized while some thought to be of the plane– has been found by investigators.

The latest development was the discovery of a wing flap near Tanzania on 21st September, confirmed by the Australian Transport Safety Bureau (ATSB).

The event is one of the most intriguing events in the entire history of aviation and has probably even surpassed the Emilia Earhart case in terms of speculations and theories which range from the plausible to the incredulous. This event is surrounded by a mysterious aura and the exact truth, if and when revealed, will probably surprise us all.

Data and pictures mainly obtained from Air Crash Investigation's episode on MH370 and Wikipedia article https://en.wikipedia.org/wiki/Malaysia_Airlines_Flight_370.

The Story of Pratham

by Ratnesh Mishra

26th September was a red letter day for Team Pratham. After beginning work 8 long years ago, their eponymous satellite- designed here at IITB- was launched by ISRO amidst profound admiration and adulation. Read on to know more about the satellite, the objectives it serves and the journey that made it happen.

Pratham was conceptualized in 2008 with the aim of making the Institute a center for space science and technology research.

The satellite is designed to fit within a cube of 30 cm side with a weight of nearly 10 kg. Among the mission objectives of Pratham, empowering the students involved with the skill set required to develop a satellite through various stages of design, analysis, fabrication and testing is at the forefront. Along with the scientific objective of Pratham, one of the goals of this project is to share with society the knowledge that we have acquired as students. The vision in mind is to start a collaboration between various Indian universities interested in contributing to the space sector and ensuring sharing of knowledge and facilities between them. Pratham is to be the first step towards that goal.

To realize this vision, various workshops and sessions have been conducted by the team in our own institute and other universities as well. That has resulted in installation of ground-stations for satellite tracking in quite a few colleges. The team is in collaboration with a few international universities as well. For the relevance of our satellite to the student community, Pratham will be transmitting satellite data when the satellite passes over India so that any interested university with a small ground station will not only be able to detect the beacon signal from the satellite but will also be able to measure TEC above their ground station. This is proposed to spread awareness among the student community about this field. The project presents a wonderful learning experience to the students of working on a real life multidisciplinary complex system.

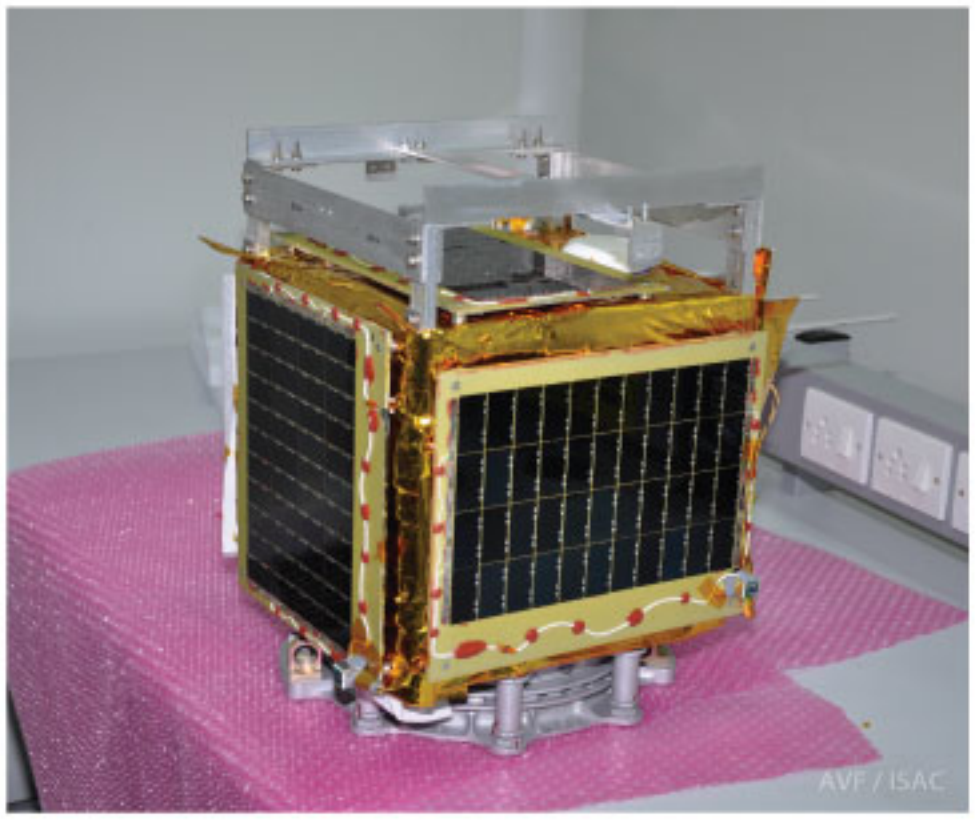
The success criterion is as follows-

Flight Model Ready	85%
Beacon Signal Received	90%
TEC measurements at IITB	95%
Satellite functional for 4 months	100%

The Mission for Pratham is:

1. Acquiring knowledge in the field of satellite and space technology
2. Have the satellite entirely designed by the student body of IIT Bombay
3. Have the satellite launched to measure TEC of the Ionosphere above India and Paris
4. Involve students from other universities in our satellite project

When all the 4 mission statements are fully satisfied - when the satellite works successfully for its mission life of 4 months in space, the project will be considered a complete success. The team has attached a lot of importance to all the mission statements. The mission life is 4 months because 2 months of data are needed to validate it against known standards, and then 2 months of additional data need to be acquired that can be claimed as unique and correct. The design life of the satellite comes from the quality of the components used in the satellite.



The various stages in the development of the satellite are Design, Analysis, Fabrication and Testing which happen sequentially. During the design phase for the satellite, various system and subsystem requirements are identified, defined and quantified. The different stages of design in increasing order of maturity are conceptual design, preliminary design and critical design. After each phase was completed by the team, a review was conducted in ISRO to assure a quality progress of the project.

Technical details of the project

Mission objective	To estimate TEC over India and Paris with a resolution of 1km x 1km location grid.
Payload instrument	Two monopole antennas transmitting at 145.98 MHz and 437.45 MHz
Structure	Dimensions: 30.5cm X 33.5cm X 46.6cm Mass: 10.12 kg Side panels: Aluminum alloy (Al 6061) Monopoles: 3
Sensors and actuators	GPS, Magnetometer, Sun-sensors, Magnetorquers
RF communication	Transmission in the amatuer band Antennas: Monopoles - Uplink (UHF), Downlink (UHF) and Beacon
Power source	Li-ion battery and 4 solar panels
Orbit	Polar sun-synchronous, 670 km Passage over India: around 11.30 IST

The Story of Pratham

The project is divided into the following subsystems as relevant to the building of a satellite:

Payload
The scientific objective of the payload for Pratham is to measure the Total Electron Count (TEC) in the Ionosphere. This is achieved by transmitting two linearly polarized beams of radio waves from the satellite and detecting the change in angle of polarization after they have crossed the ionosphere, using a ground station. By this method, Pratham will be able to measure the TEC of the region only directly above the ground station. Since the number and regional distribution of ground stations increases, more TEC data can be produced, the team has collaborated with several universities for the ground-station. TEC maps are very useful in meteorological studies and ionospheric error correction in GPS.

Power
The power subsytem is responsible for ensuring an adequate supply of power to the satellite and appropriate distribution to the various electrical loads. The satellite uses a Li-ion battery and four space-grade solar panels acquired from ISRO, to provide power to the satellite.

On-Board Computer (OBC)
The OBC sub-system is the brain of the satellite. It controls the way the satellite functions and is expected to take all the decisions for the satellite. The on-board computer regulates the flow of data, executes the attitude-control loop and other such computational/decision tasks and also decides which sub-systems are to be kept on/off/idle in emergency situations. Since a failure of the OBC results in a failure of the satellite, a lot of emphasis is placed on robustness and the resistance of the OBC to errors (hardware/software) that may occur. Space-grade components are preferred to ensure a long life for the satellite.

Attitude Determination and Controls (ADCS)
The ADCS subsytem is required to ensure the proper orientation of the satellite in orbit. When the satellite is ejected by the launch vehicle, it rotates at high velocities. In order to receive the transmitted signals by the ground-stations, the satellite needs to be at a stable orientation which is the task of the ADCS subsystem. The sensors used for this purpose are a GPS, magnetometer and sun-sensors. The actuators to stabilize the satellite were self-fabricated magnetorquers.

Structures
The Structures, Thermals and Mechanisms group has under its ambit the physical units comprising the body of the satellite. The broad function of this group is to design the body of the satellite and mount all components on it- shielding them well from shock, excessive temperatures, radiation and stray magnetic fields; control the internal thermal environment at all times and design mechanisms crucial to the working of components.

Communication
The communication subsystem is responsible for proper transmission of the signals from the satellite and reception at the ground-station. The satellite has three monopole antennas, where two of the antennas are for transmission of beacon and downlink and the third one is used for reception of the 'kill' or 'reset' signal in case of malfunctioning of the satellite.

Team Selection
Every year, around September, a selection test is taken which is open to all the students of the Institute. It consists of a quiz to screen the candidates. Then the candidates have to give a presentation on a topic that is given to them. After successfully clearing the selection tests, the candidate is inducted into the team as an informal member. After working on the team for 2-3 months, he is given formal membership if the team is satisfied with his work. In this manner, new batch of students is inculcated every year to replace the out-going batch.

Since the out-going batch leaves around April, it gives the new batch about 7 months to learn about the Satellite from their seniors. Currently, the team strength is around 30.

The various stages in the development of the satellite are Design, Analysis, Fabrication and Testing which happen sequentially. During the design phase for the satellite, various system and subsystem requirements are identified, defined and quantified. The different stages of design in increasing order of maturity are conceptual design, preliminary design and critical design. After each phase was completed by the team, a review was conducted in ISRO to assure a quality progress of the project.

Funding
All the funds allotted to this project have been provided by the Institute. The team has received a lot of technical help in terms of testing facilities and guidance from ISRO. The integration of the flight model of the satellite and all its testing have been done in ISAC, Bangalore and SHAR, Sriharikota.

Continuity
It is aimed to monitor the satellite for the next few months, tracking the satellite and analysing its health data. The data will then be distributed to various science institutes conducting research in this area.

The TEC data will be analyzed and its scientific quality determined by an error quantification and comparison with other TEC maps of the same region.

SpaceX- Challenging Conventions

by Karthik Mahesh

In the 90s, the vision that a private company would launch a vehicle into space would have been unbelievable. Yet, on July 20 2016, that is exactly what happened when a SpaceX Dragon capsule carrying cargo docked at the International Space Station.

Space Exploration Technologies Corporation, better known as SpaceX, is an American aerospace manufacturer and space transport services company headquartered in California in the United States.

It was founded in 2002 by former PayPal entrepreneur and Tesla Motors CEO Elon Musk with the goal of creating the technologies to reduce space transportation costs.

It has developed the Falcon 1 and Falcon 9 launch vehicles, both designed to be reusable, and the Dragon spacecraft which is flown into orbit by the Falcon 9 launch vehicle to supply the International Space Station with cargo.

SpaceX CEO Elon Musk says that He envisions a 'Gas n' go' system, where a rocket, after launching, lands safely back at the launch site, or downstream, and is refueled and ready to be launched again in a few hours, like airliners.

SpaceX has also won several contracts for launching small and medium-sized satellites, beating Government-funded space agencies and companies such as ArianeSpace of France and the ULA of America by pricing launches at three-quarters of their competitors' prices.

To understand how SpaceX went from being one rocket away from failure to being market, and technology leaders, one must look at the economics of space travel and rocket manufacture, and how SpaceX shook things up.

Space travel is expensive. United Launch Alliance, SpaceX's closest American Competitor, claims a launch price of $225 million per launch. This is partly because companies price launches to maximise profits, and not to minimise costs to the customer, which is usually the government. This restricts space access to government agencies and defence applications, where the reliability of the launch is much more important than outright price.

Another part of the problem is the management structure of NASA and similar agencies- where typically, manufacturing and design of thousands of smaller parts is subcontracted out to other companies; which inflate their own costs to increase their profit margins. As an example, NASA may award a contract for building a new space vehicle to Boeing, which then awards contracts to design and manufacture parts to its vendors. Cost inflations aggregate over levels in this manner.

Elon Musk, back when he considered investing in a mission to launch plant life to Mars in 2001, was shocked by the amount of money he would have to shell out. After having acquired millions in the sale of PayPal, he then decided to build rockets himself. He had already spent months studying the Aerospace industry, and realised that rockets aiming to launch smaller payloads for commercial and research activities could be manufactured and launched at much lesser prices.

With a team of veteran Aerospace Engineers and about $20 million, Musk established SpaceX with a goal to make lower-end launches routine and affordable.

The focus was on cost reduction from the start, taking design commonality and economies of scale into account. The Falcon 1 rocket uses 1 indigenously designed Merlin engine while the Falcon 9 uses 9

NASA has awarded 20 launch contracts to SpaceX worth billions of dollars, and is planning to award contracts for crewed launches soon.

Why should a rocket be reusable though? If the demand for launches skyrockets in the near future, then reusing the entire rocket could cut prices by an order of magnitude, thereby increasing access to space. Also, for an interplanetary mission, especially one involving humans, the rocket has to be able to be relaunched after refuelling, as it is the only escape vehicle available.

The history of rocket reusability is a chequered one. The Space Shuttle, which first flew in 1981, was a notable attempt at creating a reusable system, but was only partially reusable. The external fuel tank was expended on each mission, and although the boosters were reused, they were parachuted back into the ocean, which meant that they needed a costly overhaul. The silicon tiles which protected the orbiter from re-entry heating required costly maintenance work between flights. Overall, this pushed the number of flights back to 1/4th of what was originally planned, making it economically infeasible.

SpaceX's first attempt at developing such a system was the Grasshopper rocket, powered by the Merlin engine. Reusability was then incorporated into the Falcon 9 starting 2015, and the first successful landing was made on 21st December 2015. They have since landed the first stage of the Falcon 9 rocket 5 times out of 10. Achieving reliable reusability of the first stage would push costs down by about 30%, and full reusability even further, allowing SpaceX to dominate the launch market and take humanity one step closer to becoming a multi-planetary species.

LCA Tejas and beyond

by Vipul Goyal

The Design and development of the Light Combat Aircraft (LCA) Tejas was a milestone in the history of Indian aviation- aiming at replacing the aging Mig-21 fighter aircraft fleet by an indigenous product. Reaching the stage of obtaining the first Final Operational Clearance (FOC-1) has been commendable owing to the fact that it has not seen even a single accident, with over 3000 flying hours in diverse conditions (from high altitude Leh to hot Jaisalmer deserts) and has been adjudged as a very pilot- friendly aircraft. Another major contribution of the LCA program has been the successful setting up of an engineering and manufacturing ecosystem in the country which was dormant for many years.

Development of Tejas was facilitated by the Kaveri engine- a landmark project taken up by Gas Turbine Research Establishment (GTRE), a DRDO Laboratory, to power the indigenously developed Light Combat Aircraft (LCA) which has been handed over to the Indian Air Force recently.

The engine was tested on a flying test bed in Russia a few years back, during which it fell short of fulfilling the requirements of the Light Combatant Aircraft (LTA) by 25%, especially in generating sufficient thrust in the afterburners 'on' condition.

In gas turbines, Overall Pressure Ratio (OPR) and Turbine Entry Temperature (TET) determine the efficiency of the engine. In order to compare Kaveri with other state of the art engines, one needs look no further than F404 engine which is being used in LCA currently. A quick glance at the performance parameters reveals that Kaveri has comparable Specific Fuel Consumption (SFC), average stage pressure ratio, thrust etc. The major problem has been the engine weight which is 200kg heavier than specified and this, as a result, shrinks the performance envelope of aircraft significantly. It also has lesser TET (close to 1400 degree C) compared to other engines (TET in the range of 1450 – 1650 degree C). It also has a worse afterburner SFC owing to its low bypass ratio (0.16 compared to F-404 having 0.34).

Recently, after industrious efforts, DMRL has succeeded in developing single crystal technology indigenously with first generation superalloys, with capabilities for thermal barrier coating demonstrated. These two technologies combined have the potential to take the TET higher by 200 degrees.

A major stumbling block has been the lack of full scale test facility in the country. Bulk of the testing was conducted in Russia, which caused a lot of delay and increased the program cost. Generally, this also hinders the incorporation of any changes during the program. Above all, despite not fulfilling the LCA requirements completely, the core Kaveri engine (without the afterburners) has performed very well and the program has established an excellent environment in the country where future research and engineering can flourish.

Tejas is a 4++ generation fighter aircraft. With the ever evolving battlefield scenario, the Indian Air force needs to possess a more advanced aircraft to ensure air dominance in the years to come. Therefore, India needs to leverage the skill set developed during the Tejas program and embark upon a 5th generation fighter aircraft program to match the capabilities elsewhere in world. Development of such a fighter will also be beneficial to the Indian industries and the society in the long run, considering the many sophisticated fabrication orders it will execute and the employment which it will create.

Stealth, super maneuverability and supercruise technology in Indian aircrafts are still in their infancy and significant inroads need to be made into these unchartered territories.

Recent deals between India and foreign companies -Dassault (for Rafale) and Sukhoi (for FGFA) - are supposed to bring new technologies to the country as part of 30% offset policy.

France has offered to help India revive the Kaveri engine project for indigenous Tejas aircraft and a host of other high-end collaboration as part of the offsets in the multi-billion Euro Rafale fighter plane deal which is now in the final stages.

This does not diminish, however, the need to innovate and create strategic technologies such as stealth indigenously. After the great success of LCA, the onus is on us as a nation to take programs like these to far greater heights. In future ventures, with the Center for Propulsion Technology coming up, IITB can have a pivotal role to play in the design and development of new aero engines. Due to requirements of new engine for upcoming Multirole fighter (AMCA), path breaking research needs to be done to achieve the ambitious goals of increasing thrust of the engine to 1.5 times and blending it with a stealth platform.

Tete-a-Tete with Prof SP Mahulikar

by Himani Sinhmar

Prof. Shripad P. Mahulikar obtained his B.Tech. & M.Tech degrees in Aerospace Engineering from IIT-Bombay in 1991 & 1992, respectively. He then joined the Defense Research & Development Organization as a Scientist & worked there for 4-years towards the completion of scholarship bond period during education at IIT-Bombay. He obtained PhD in Laminar Micro-Convective Flow from NTU - Singapore in 1999 & joined IIT-Bombay as Assistant Professor in 2000. He was awarded the A. von Humboldt Fellowship thrice [2003, 2007, 2009] for pursuing collaborative research with T.U. Hamburg, F.R. Germany. He received the Outstanding Reviewer Award for ASME Journal of Heat Transfer in 2007. In 2011, he was appointed as Mercator Chair Professor sponsored by DFG (German Research Foundation) in T.U. Hamburg. His classroom teaching subjects include Propulsion, Thermodynamics, & Heat Transfer. His research areas include – (1) Infrared (IR) Signatures of Aircraft & Helicopters; (2) Study of Laminar Micro-Convective Flow & Heat Transfer; (3) Entropy Generation Studies in Laminar Micro-Convective Flow; (4) Non-Equilibrium Thermodynamics of Dissipative Structures and (5) Aero-thermal Mapping of Passive Thermal Protection System of Reusable Hypersonic Vehicle. He recently published an important paper with radically new concepts in Black-Hole Thermodynamics, co-authored with his PhD Research Scholar.

We discussed with him his academic experiences, non-academic pursuits, & several other aspects of living in general.

Q: When was it that you decided to become a professor?
A: After graduation from IIT-Bombay in 1991, I realized that formal learning is only the 1st step. A lot of additional learning must be captured through independent self-thinking.

Thinking in an unconventional way about Jet-Propulsion concepts enabled me to publish an international peer-reviewed conference paper, just after graduation.

My objective in life is to continuously learn & the best way to learn is to teach & pursue self-motivated research.

Q: What is the best thing about being a professor? Would you like to share any unique experiences?
A: My main purpose of living is to find the truth clearly & being in academics, I can use this opportunity on a daily basis. In several other professions, one's thoughts are constrained by daily routine tasks that are governed by the rat-race. But in academics, it is possible to think independently & understand the basic concepts with clarity for acquiring additional knowledge & for widening exposure.
I feel that rather than one or two incidences, it is the journey as an academician that is more important. My journey has been most satisfying from the point of view of my personal aspirations, which I envisaged soon after graduation.

Q: You served as a professor in IIT Mandi on deputation. Was there a tangible difference you felt teaching there?
A: There was no difference from a personal view-point. In terms of my theoretical research & teaching, which continued as they were on deputation from IIT-Bombay to IIT-Mandi & earlier on sabbatical from IIT-Bombay at T.U. Hamburg Germany. Only the system and students can differ but my academic routine was not affected.

Q: What is your opinion on the new IITs being opened by the Indian Government? Is it a much needed plan or- as some argue- a dilution of "Brand IIT"?
A: Being a government servant, I will not be able to comment on the government's decision, which may also be based on socio-economic factors in addition to academic.

There is certainly a difference in the system of the new & old IITs. It is important for the new IITs to maintain certain minimum norms & standards, which is the most generic & appropriate comment that I wish to make.

Q: How would you explain your current area of research to a 17 year old fresh out of school?

The true test in understanding the clarity of a new research finding is the ability to explain it unambiguously to a high school graduate.

I make a conscious effort to do so especially with my fundamental research findings. But there are some specialized research topics, which cannot be explained without the use of scientific jargon and domain specific words. Thankfully, such research areas generally appeal only to a small community of researchers.

Q: Recently you published a paper depicting a Black Hole as a dissipative structures using negentropy. This is being considered by some as a milestone in Black Hole Thermodynamics. Tell us more about your work in this field.
A: I started pursuing research in the Basics of Thermodynamics (a trans-disciplinary) subject in 2003, after realizing that I'm actually ignorant about the very fundamental and abstract theoretical concepts, e.g. entropy. I then applied my limited understanding of these concepts for the scale-free description of ordering processes.
I then started understanding black-holes using their entropy, which has been reported by several other researchers also. Since, black-holes are a limiting case of ordering, they "kind of have a life in them", termed as a "dissipative structure" by I. Prigogine; which is better described using E. Schroedinger's negentropy.

My future research driven by curiosity aims at understanding the role of black-holes in the evolution of the universe and exploring how the negentropy of black-holes will change with the age of the universe.

Tete-a-Tete with Prof SP Mahulikar

Q: What are some of your other research areas?
A: My other research areas include designing an IR-stealth aircraft, i.e. making an aircraft engine stealthy with respect to IR-guided missiles. This research area is of contemporary interest, due to the importance of stealth technology in the design of military aircraft. I also work on microchannel cooling of gas turbine blades, which is a limiting technology for enhancing the performance of aircraft gas turbine engines, by enabling increase in the combustion temperature. I pursue applied research concurrently, without compromising on my fundamental research curiosity.

Q: There has been an increase in the percentage of students joining Non-Core jobs in Aerospace department. Why do you think has this happened?
A: In India, the society attributes happiness mainly to money; therefore, monetary richness is held in high esteem; consequently, people aim for financially lucrative jobs. We should compare the remuneration a core job offers relative to a finance job in an international bank. E.g. the nature of work of an Aerospace Engineering graduate employed in Deutsche Bank is completely different from the undergraduate training received. It is the material gain in the form of pay-package that drives most to non-core sectors.

Q: Don't you think this is a matter of concern regarding the future prospects of the Aerospace industry?
A: As we are in a democratic country, we cannot influence or restrict someone for pursuing a particular career. At my level, I attempt to create interest among my research students on the understanding of the physics of the problem and the importance of research-oriented thought-process. I emphasize the importance of learning a subject from the basics and with depth. Also, I try to inculcate the philosophy of living for learning in my research students.

There are very few select students who follow and advocate this line of thinking. I try to discuss exclusively with such people & fortify this thought-process in them, for proliferating the importance of learning & understanding with clarity. When this belief is popularly accepted, only then people will stop blindly chasing money & will work to satisfy the curiosity of their soul & conscience. I do not mean that what most other people do is wrong. I am just saying that there is another approach to a healthy life-style, which can give different rewards that can be gauged based on the satisfaction of soul & conscience rather than conventional material gains.

Q: If you were to give one piece of advice to a freshman, who just got into an IIT, what would it be?
A: Always be true, honest, and sincere at least to yourself, even if you cannot make everyone happy at the same time. The resulting balanced approach is crucial for evolving towards an ideal person and the blissful end result will be path independent.
Like we were discussing about somebody wanting to do finance, somebody wanting to remain in core discipline, somebody wanting to enter academics, etc. May I give just one path-independent advice – to be true, honest, and sincere at least to your soul & conscience. These qualities will ensure that you go a long way in life, & localized fluctuations will never affect in the long-run.

Buzz at the Watercooler

HPC

'Compute Mavericks' is one of India's few student supercomputing team and is based in IIT Bombay. Currently it comprises of 8 students- all of which are from the Aerospace Department and have undergone a course in HPC (High Performance Computing).

HPC is a niche field which deals with solving mathematical equations on computers. The mathematics involved is highly computationally intensive. Examples include flow simulation around aircraft, ocean simulation, weather simulation, machine learning etc.

The team will be participating in 4 student cluster competitions over the coming 1 year in India and abroad.
1. ISSC (Indian Student Supercomputing Challenge) during Techfest.
2. ISC (International Supercomputing Challenge) in Germany.
3. SC (Supercomputing Conference) in USA.
4. ASC (Asia Supercomputing Conference) in China.

The competition organizers provide a set of code bases (applications) during the start of the competition. The goal is to design a hardware (cluster) and tweak application for it to achieve max speed under a power cap of 3kW. The team is currently involved in preparing for ISSC.

To find out more, visit teamindia.de-hpc.org

67th Annual General Meet & International Conference

The Annual General Meet & International Conference on "Next Generation Skill Development" & "Challenges in Aerospace/ Aeronautical Industry" was jointly organised by AeSI (Aeronautical Society of India) Mumbai and AEA (Aerospace Engineering Association) IIT- Bombay at VMCC on 14th-15th Oct. 2016. Hon. Minister of Civil Aviation P.Ashok Gajapathi Raju was the chief guest of the event.

Various technology development & their challenges in aerospace sector were presented by lead scientists, engineers of renowned research & development institutions of our country like ISRO, DRDO, DRDL, HAL etc. The Conference envisaged the national importance of Skill India & Make in India campaign for aerospace & aeronautical industry. The topics presented by the speakers included "Building & Sustaining Indigenous capability in Aerodynamics", "Challenges Faced by a Designer" and "preparing Indian aviation for the next decade".

Intern Diaries - Gulfstream

by Ashwin Kanhere

The views expressed here are the author's and are in no way a representative of how people at IITB really think. The author is quite stupid compared to them. But also very lucky, hence we're here. The views represented here are also not a representative of Gulfstream Aerospace Corporation, which was a fun company to work at and certainly knows its stuff.

'You know nothing Jon Snow.' Most of us must've seen the stunning Rose Leslie deliver this line on TV's Game of Thrones. But have you ever stopped and wondered, 'How much do I know?' Don't worry, I've done your work for you. You know nothing too. (Go ahead. Curse me for my 'holier than thou' attitude. Call me a pessimist. But it's definitely true.)

Fair enough. You say. I might not know everything possible but I know something about my particular area of expertise. So, I don't know nothing. (My English teachers, go ahead. Shoot me for using the double negative.) Even I used to think that, being an aerospace engineer in the making, I had a fair handle on how things were done. I have never been more wrong. (I might have been, but that doesn't drive the point home with as much force does it?)

I was one of the fortunate two students from my batch to get an internship at Gulfstream Aerospace Corporation in Savannah, Georgia. And what I've seen here has changed my perspective of my professional life forever. (That is, until I'm hit really hard on the head and I forget everything I've seen upto that point.)

The very nature of the industry is such that I can't give out any details about what I'm doing or how things are done at Gulfstream. However, I will try to share the broad aspects of how I got the internship and what working here has been like so far.

How'd I get an intern here?

Gulfstream Aerospace is one of the few only core Aerospace Engineering companies that comes to the PT cell and has been doing so for the past six years. It is a program unlike any other because of the unwavering effort put in by Ms. Gita Mirchandani of Gita PR, who coordinated with the Gulfstream leadership (as the upper management is called here) and the PT cell at IIT Bombay. The process takes a lot of time and begins with a resume submission on the portal in the autumn semester, following which, a telephonic interview is conducted in the Spring semester. The nature of the interview is mainly to get to know the candidate better and make sure that he'll fit in with the group which has selected him. Confirmation was quick, and I found out that I was selected the evening of my interview.

Life in the US of A

Unless you've been to the country before, it's going to be a shock when you find yourself thousands of miles away from home and alone, truly alone for the first time. (I had visited the US before, but a parent supervised visit and living here on your own for two months are complete opposites of each other).

It is very easy to become self-reliant in the US. That's the way their economy is built. However, one thing that's going to strike you the moment you reach is that getting around here is a problem. The South is spread out and very difficult to navigate without a car. (No. walking and cycling here aren't as easy as you think they are. The massive cars, high speeds and massive roads are a slight hiccup).

Intern Diaries - Gulfstream

Your parents won't have to worry about you getting enough to eat (as long as you're being paid which you should be because the labour laws here are followed). What you should worry about is the fact that you're going to have to clean up after yourself (lazy people like me hate this).

Working at Gulfstream is like working in any big company (so I gather from what I've heard). It has made me value human interaction and how important collaboration and proper communication are to having a successful professional life.

For the people amongst you who are interested in doing engineering in the future (if you're not, don't know why you're reading this, but flattered) never forget the value of actual engineering. It actually drives a lot of design in ways you would not have expected. And it is not easy as you'd think it is.

And, if you're lucky, you'll get to see a Gulfstream being made. They're sleek and a sight to behold. The fact that you can see what you're working on sitting in the hangar in front of you is inspiration unlike any other.

Future Prospects?

That's the thing about Gulfstream. They have a very diverse workforce with people from Brazil, India, Australia, UK and a host of other countries joining the indigenous workforce. Because of the fact that they have such a diverse workforce already, and also, I think, aided by the fact that they make civilian aircraft makes Gulfstream a very good place to start working. It gives you a good entry point into the industry. And even if you decide not to work in America, the Aerospace industry is up and coming in India and you could do with the experience.

You might not be given important or complicated stuff to do, but all of your colleagues will treat you like you're an equal.
Trust me. There is nothing like this.

And for all the airheads out there, the fact that Savannah Hilton Head International Airport plays home to F-15s and C-130s which you can easily see flying from where you work is a fun advantage that keeps reminding you about the beauty of aerospace engineering.

Smitsonian Visitor's and Information Center

**The Savannah Bananas baseball game.
We had free food passes.**

What else can I do other than work?

Gulfstream's hours make it easy to do whatever you like doing in the evenings. While you might not have heard of Savannah, it's a nice place that has a surprisingly large amount of history behind it. You will not regret a visit downtown.

Atlanta is close by, is a big town that has a host of attractions such as the Georgia Aquarium, World of Coke and Six Flags Over Georgia. Since your pay is quite handsome, you need not be restricted to the state and you can even visit other cities in the US such as New York and Washington DC.

All in all, I have loved every single part of being at Gulfstream. The memories, experiences and friends that I've made will stay with me forever. (Or until I get bonked really hard on the head.)

The internship also gives you the opportunity to work in a real-life professional setting. Not one where you're coddled because you're an intern.

What does the future hold?

by Pulkit Balhara

Right now, when we wonder about how the future of aerospace would look like, we think of hybrid jets, flying cars, advanced missiles, and Mars bound rockets. How feasible is their execution? What are the challenges to existing technology? And how can they be overcome? We dig into such unexplored areas and find out the avenues for research in this piece.

When we see aeroplanes, what is visible to us is only the hardware. The newest flying machines demonstrate what goes into the air but one doesn't notice how the systems on a vehicle control that vehicle, converse with the ground control and with other vehicles. How is the data collected? And what is done with that data? This area of aerospace engineering is where the future technological advances will happen. Let's find out why that is the case.

The reason is the rise of System Software. Programming in Aerospace is slightly different when compared to what is done in making apps and video games. One has to create a code which can handle real life situations and their system dependent response. Before writing the code, one has to know all the functionalities of hardware- how it behaves to situations which are not ambient, how it might fail, its response under stress et al. And obviously the code must be bug free, or the result is disaster. Statistically, air transportation is a much safer method to travel as compared to land, which is because these codes work very efficiently. However, there is much scope for improvement.

Today, software is handling ever-greater percentages of the jobs done on an aircraft. These systems are being developed and put in place by companies such as Ultra-Electronics and Rockwell Collins with increasing frequency. Increased and better communication with ground control will soon allow for more efficient landings.

Currently planes approaching an airport do so in a stair-step process. This allows the control tower to maintain safety at each stage. But when the exact position of each plane is known, the approach can be continuous. The smoothness of the descent will mean every flight will be shorter by two or so minutes and save about 100 gallons of gas. That time may be minuscule for the passenger, perhaps, but worldwide, the savings are enormous. And one can only imagine the benefits of reduced fuel consumption. There is certainly a lot of scope for writing a "super code" which solves an optimisation problem and saves fuel, time and increases safety manifold.

Another problem that we can we identify is in intercraft communication. For passenger planes specifically, individual planes have to talk to the Air Traffic Controller wherein some irregularities in conversation have led to fatal accidents. A better idea would be to also have a inter aircraft communication with those planes who are in proximity. There is then a lot of scope for work in innovating new technology to solve this problem. And just as now vehicle to vehicle communication has facilitated the development of automatic cars, aircraft to aircraft interaction might soon make the man in a manned aircraft a little less necessary.

The desire to fly is what made man to invent the first aircraft. With the advent of technology, we might soon be moving away from airliners now to flying cars and assisted personal flight in the not too distant future. There are companies which are working on developing jetpacks to even flying cars. The main motivation, apart from the thrill of actually owning a flying car, is solving, once and for all, the problem of over crowdedness. Surely the morning commute is not likely to crowd the sky the way it does our streets.

These are some of the challenges we expect will be solved in the not-so-distant future. With aerospace engineers at the helm of cutting edge technology, the future is ours to design.

The Last Word

Hi everyone!

I hope you liked the first ever edition of our department newsletter. We've tried to cover diverse issues of importance to the Aerospace industry and published what is hoped would be an interesting read.
I would also like to take this opportunity to thank Insight for their help in bringing out this issue. Shoutout to Rishabh Israni for editing the newsletter and to Shievani Upadhyay for the wonderful design.
Thanks are also due to everybody who contributed articles to the newsletter. It's your efforts which have made this possible.
Please feel free to bring any comments, suggestions or ideas for new articles for future editions to my attention.

Cheers!
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