



**SECOND BOEING 777X  
COMPLETES FIRST FLIGHT**



**SPICEJET GETS DGCA  
APPROVAL FOR DRONE  
TRIALS**

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# UPDATE



## AI IN CIVIL AVIATION

**Tejas FOC Aircraft Handed  
Over to the IAF**



Representation of an AI  
(Credit: <https://>)

**"The Engine is the HEART of an Airplane But the Pilot is its SOUL"**

**\* Pilot  
\* Engineer**

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**FASTEST FLYING AS COMPARED TO OTHER SCHOOLS IN INDIA**

# TRANSFORMING FLYING MACHINE FROM FLYING COFFIN TO FLYING ANGEL

**O**n 08 May 20, at 10:45 AM, one Mig-29 Aircraft airborne on a Combat training mission from an Air Force base near Jalandhar (Adampur) met with an accident. The aircraft had developed a technical snag and the pilot ejected safely as he was unable to control the aircraft.

## Flying Machine

Aircraft are machines and they fail. Flying is inherently risky. Each fighter jet is as important as any equipment in the military and costs 100's of million. The aircraft itself has a flight life. With limited budget available, India prefers to overhaul, so that it comes out with zero hours on the airframe, new wirings as well as hydraulics, avionics, etc. as well as overhaul of the jet engine. Hence the overhauled aircraft will be around for another 15–20 years!

However, in peace time IAF does a lot of flying and hence few incidents / accidents are inevitable. As opposed to what people comprehend, IAF has the lowest attrition rate in years. During combat the life expectancy could seriously drop due to damage, aggressive performance, and climate and possibly add bad maintenance to it. Not literally, but somewhat true, A 50 year old geezer MIG 21 shooting down a F16, demonstrates that when jet fighters are in good hands, it doesn't matter how old the aircraft is even the world's most rugged aircraft can be turned into ball of flames. Proudly say Congratulations (Abhinandan).

Except the new entrant Tejas and Rafale, all other flying jets are at least 10–15 years old (Sukhoi and MIG 29) or more than 25 year old (Mirage, Jaguar, MIG 27, MIG 21). An airframe life for a jet fighter is normally between 2500 to 8000 hours. Every Aircraft comes with limited flight hours after which either it has to be overhauled or replaced.

## Flying Coffin

In 2012, Defence Minister A K Antony told Rajya Sabha that 482 of the 872 Russian-origin MiGs procured since 1966 had crashed from 1971-72 onward. "A total of 171 pilots, 39 civilians, eight service personnel and one aircrew lost their lives in these accidents. The



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causes of accidents were both human error and technical defects" he said.

These big losses have resulted in hard-hearted and unsolicited words like "Flying Coffin" or "Widow Maker". Many of the jets couldn't be retired due to the gap in the fighting force and this resulted in the Indian Air Force going through some inspections of the jet to see if they can continue to be airworthy even after their expiry date. Some are plagued and have crashed killing many pilots. After every aircraft crash a postmortem exercise is carried out and couple of series of aircrafts are grounded for time being. Crashing of IAF aircrafts are due to mix of problems that includes: -

- **Advanced Age and Overhauling:** - Aircraft's have become old and are over-due for replacements. In reality, many aircraft start to fail their structural integrity because of hard performance, hard landing and even climate can reduce the life. Some of these failures results in structure damage that are beyond repair, in fact beyond economical repair. If the jet fighter has been put through some aggressive performance, the airframe may incur some stress on certain areas and this can lower the life expectancy of the airframe. Due to inherent design of aircraft, the damage or crack on inner side of skin or frame cannot be detected or visualized even by using best monitoring methods.

The propagation of cracks and its extent of deteriorating the inner surface is difficult to determine, distinguish and discriminate.

- **Human error:** - "To err is human." Human life and collateral assets are on stake either it is a Pilot error or a Technician error who certifies air worthiness. Pilot who loose life carry more damage than loss of aircraft and financial implication. Game of accusations and allegations start after an aircraft crash. The point is whose mistake is it? Blame game extends with two words Spatial Disorientation, wherein in onus of failure is transferred on pilot. Flight Lieutenant Abhijit Gadgil lost his life in air crash after only 33 seconds of flying time. Entire blame was shifted on the able Pilot. The grieving mother Smt. Kavita Gadgil fought for 3 years to bring back the honor for her son substantiating that it was not her son's fault but a technical malfunction. The accident that launched war for justice by Kavita Gadgil was a partial inspiration to film maker Rakeysh Om Prakash Mehra's blockbuster, Rang De Basanti, which portrays a mother's arduous efforts to clear her son's name.

## Technology :- Inappropriate outdated technologies & conventional methods used check the Structural integrity of Aircraft's.

**1. Conventional NDT Techniques :-** For SHM, there are many established NDT (Non-Destructive technology) procedures being practiced the world over. However, almost all these technologies employ contact-based sensors (Strain Gauges, Pressure Sensors, Load Cells, Ultrasonic Pulse Velocity Meters, Rebound Hammer, Piezo Electric Transducers, X rays, Fiber Bragg Grating Or even Radar etc.) and have serious constraints in monitoring the entire spectrum of frequencies of vibrations,

**2. AREA OF COVERAGE :-** NDT practices limits area of coverage for a given frame. Only at key points load testing's or deflection testing, porosity or any damage is checked. These tests are all stratified sampling in nature. Hence depending upon the structure barely few sq. mt. of area is covered. Visually also limited area is covered for naked eye. Something what is exposed is pondered. Monitoring is conducted at areas that are susceptible and leading to uncanny vibration or sound.



**CATS SHM**

- Level 1 : **Detection**- simply answers the question: is there a damage?
- Level 2 : **Localization**- capable of specifying the location of the damage within the structure
- Level 3 : **Assessment**- capable of specifying the type and extent of damage
- Level 4 : **Prediction**- capable of estimating the remaining useful life (RUL) and safety



**3. Damage Perspective :-** One of the main challenges for both multi-point (FBG-based) and distributed sensing techniques remains the development of reliable methods to monitor key structural parameters related to damage inception and growth over structure frames, with suitable physical and spatial resolution, especially when the damage position is not known a-priori with sufficient precision.

**4. Accessibility :-** In spite of the ability to distribute FBG sensors or X-Rays or Ultra-sonics across large areas of the structure, there still would be inaccessible but critical locations which would not be available for monitoring.

**5. Interrogation :-** The need for an effective interrogation system can prove to be complex especially if large areas with multiple sensors are present.

**6. Redundancy :-** Damage to any of the FBG sensors (which is quite common) due to extraneous loads and environmental dynamics may result in a total collapse of the interrogation system unless redundancy is implemented in the design.

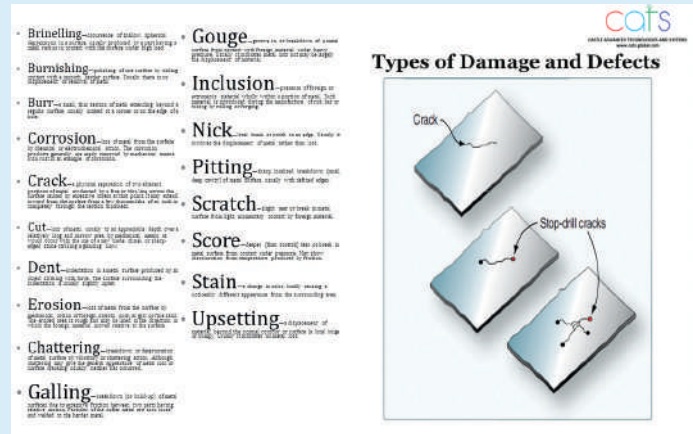
Only solution is to retire the aircraft once it has reached its expiry date OR update and overhaul to extend its air frame lives!

**Flying Angel**

Unseen cracks and damages act like cancer and accelerate deterioration of structures in shortest time. Continual stress potentially increases damages. Hence a complete end to end system is required that over comes limitations of conventional system. Evolving indigenous technologies need to be accepted and promoted that claim a complete aircraft can be scanned like a human MRI scanner. Visualize in analogy of MRI scanner, Aircraft moving inside the hanger, getting overall scanned, monitored for Structural health and integrity without any human intervention and after 2-3 hours exiting out from other side. This will include laser-based scanning (photonic) on every external section and internal section where light can reach and visual examination using thermal imaging. Please check the av below.

**Photonic Structural Health Monitoring System**

Against this backdrop, Photonics Monitoring is a breakthrough in NDT procedures. The systems are novel and innovatively uses principles of laser back scattering in the environment of operation. CATS is the only company providing single laser Sensor that can monitors and records



various Movement, Force, Environment, Acceleration, Displacements, Velocity, Load impact, Damage detection, Sound etc. It is one of its kind non-contact & non-imaging techniques for remote monitoring. Accurate qualitative and quantitative data is collected in real time using a single laser source as a function of time and space.

Photonic system detects and identifies types of structural defects, material deterioration or any signs of structural distress and deformation, alteration and addition in the structure, crack, damage or overlain with material, Potential / prospective fractures, increasing gaps between disjointed hinges, potential impact areas while landing, etc.

**Maintenance Repairs and Overhaul (MRO):**

- Aircraft should undergo, Service life Extension Programs (SLEPs). HAL has engineering competences for more than 7 decades. The MRO activity by HAL will accomplish clarion call of Hon. Prime Minister MODI of being "AATMANirbhar" (Self Reliant to Self Sufficient) and also by Finance Minister Smt. Nirmala Sitharaman said that "Steps will be taken to make the country a hub for Maintenance, Repair and Overhaul (MRO) of aircraft. Not just civil aircraft but defence aircraft can also benefit from the MRO if we make India a huge hub." HAL as MRO can assist in establishing state of art engineering evaluation of a model's structural integrity using photonic system. After due scanning, the aircraft model will be certified as structurally sound, and of air worthiness. This can extend the service life by a certain number of additional flight hours without an upgrade/modification, or; keep flying the planes after evaluation. As time taken to scan is hardly less than a day, All variants of aircrafts can be certified by regular scanning before flying or immediate after the flight. This will keep it ready for any training flights or predicaments.

**This will successfully result in attaining SHM objective for Airworthiness**

To provide an automated and real-time assessment of a structure's ability to serve its intended purpose. To identify damage at the earliest possible opportunity so that corrective action can be taken to :-

- minimize downtime,
- Operational costs,
- Maintenance costs and to reduce the risk of catastrophic failure, injury and loss of life