# ONLINE INTERACTIVE SESSION WITH DR. ABHAY PASHILKAR

On December 06,2020 the students of the batch of Class 8 to Class 12 of Aryaan Study Circle and Mushtifund Aryaan Higher Secondary School were privileged to meet Dr. Abhay Pashilkar, Ph.D.

It started with introduction of Dr. Pashilkar.

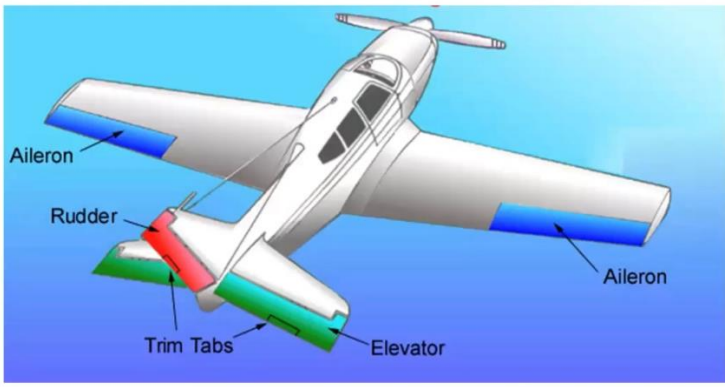
Dr. Abhay Pashilkar joined the Flight Mechanics and Control Division, National Aerospace Laboratories after his M.E. from the Indian Institute of Science, Bangalore in 1993 and B. Tech from IIT Kharagpur both in Aerospace Engineering. Since 1993, Dr. Pashilkar has worked on national projects like the LCA Tejas and SARAS. He has a Ph. D from the Indian Institute of Science in 2002.

Dr. Pashilkar was with the NTU, Singapore for his post-doctoral fellowship from 2003 till 2005. Dr. Pashilkar was the Group Head, Flight Simulation in the division from 2008 till 2016. Since April 2014, he was also the Deputy Head of the Flight Mechanics & Control Division. Since 2018 he is heading the Systems Engineering Division of NAL and is presently the Program Director for Civil Aircraft Projects at CSIR-NAL.

Dr. Pashilkar is a recipient of the 2001 CSIR Young Scientist Award and the 2003 INAE Young Engineer Award. He has coordinated the “Mirage FoC Upgrade Project” which received the CSIR Technology Shield for 2019 from the Honorable President of India. He also has many research papers and technical articles to his credit.

Dr. Pashilkar delivered a presentation on the topic ‘Artificial Intelligence -and Future of Flight control’. He started the presentation by explaining about automation and control. He stated that everything around us from a simple thermostat or a water heater to an automobile or an aircraft has some amount of automation.

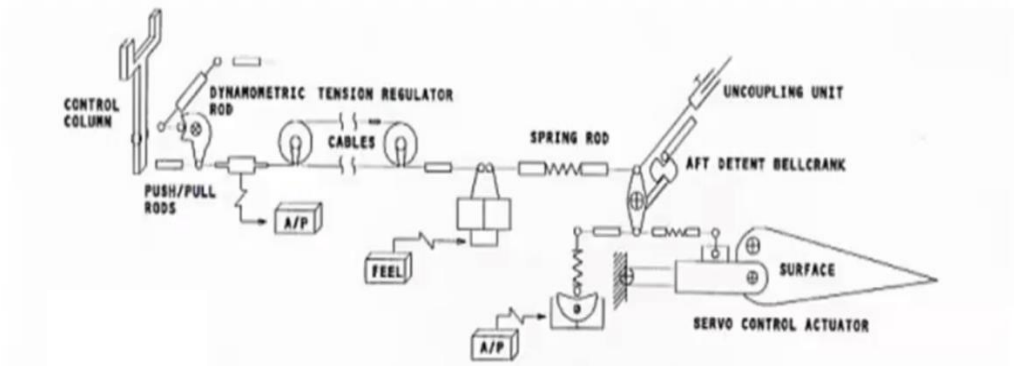
He displayed a schematic of a single propeller aircraft with various flight controls marked on it. Ailerons, Rudder, Elevator are three of the important components used to control the aircraft. The Ailerons are used to control the aircraft in longitudinal direction (lateral stability), to bank the aircraft in left or right direction. The Rudder is used to control the aircraft in vertical axis (directionally stability) and is used to turn the aircraft left and right. The Elevators are used to maintain longitudinal stability (lateral axis).



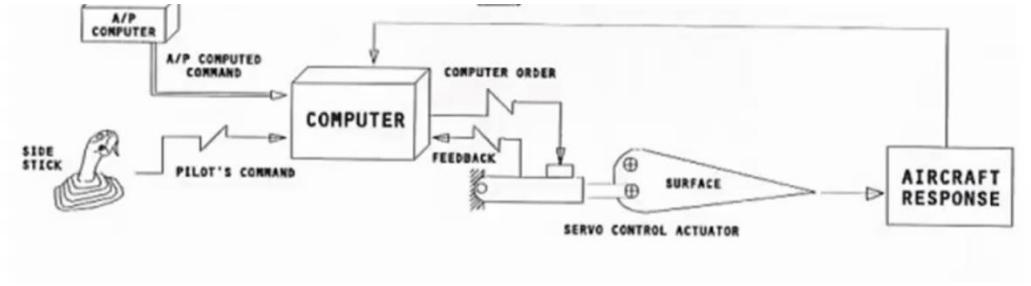

*The flight controls of an aircraft.*

The control column in the cockpit of an aircraft is controlled by the pilot. The control column is connected to various control surfaces by rods and cables. When the pilot moves the control column there is a disruption in the airflow around the aircraft which enables the aircraft to make movement.

The Autopilot is an electronic control system which is connected to the entire system. The Autopilot allows the aircraft to fly without manual intervention. Today, in aircrafts the rods and cables are replaced by computers. The command which the pilot inputs with the control column (side stick) travels as electrical impulse to the computer which computes the signal and relays it to an actuator which moves the mechanical devices connected to the control surfaces.




*Flow chart traditional flight control system*




*Flow chart displaying Fly-by-Wire Philosophy*

In the Autopilot the measurements of the aircraft response, data from various sensors like accelerometer, altimeter etc. are fed to the computer as part of the control log. The computer calculates and gives the command to the aircraft respectively and the pilot only acts as supervisor as he doesn't have to command the surface but must go through the computer.

There are multiple computers and sensors to avoid any anomaly in in information relay. Dr. Pashilkar mentioned that the Boeing 737 Max had only one set of sensors controlling the aircraft. The failure of this sensor caused two aircrafts to crashed and due to that there was a 20 month down time on the project. Dr. Stated that "Even Human Beings make mistakes so even such a system is prone to mistakes". He stated that when they implement the system in real world, the computer is programmed for is hypothetical scenarios that may likely occur. But reality is different and when it's tested, they may find conditions that they may have thought are not possible. Thus, they use different kinds of sensors for a said function, multiple similar sensors that are kept away from each other so that if one fails other is not affected.

*The LCA Tejas*

Then Dr. Pashilkar spoke about the light combat aircraft Tejas. A fourth-generation combat aircraft that India has developed in a time period of 30 years. The aircraft is capable of both day and night combat missions. The LCA has three variants, the Air Force variant, the Naval variant and the Trainer variant. The naval variant is capable to take off and land on aircraft carriers using the ski jump ramp and arrestor wire. He mentioned that landing on an aircraft carrier is more difficult than on an airfield as the ship is constantly in motion and if the hook is unable to catch onto the arrestor wire the pilot has to take off and attempt to land again. The aircraft is equipped with flares (countermeasures of chaff). The flares have very high heat signatures which distract an enemy missile away from the aircraft. LCA Tejas is also compatible with laser guided bombs, air-to-ground missiles, and air-to-air missiles.

Artificial Intelligence is when a machine is programmed to do certain tasks like speech translation, natural language processing, walk, climb and crawl on their own ; identifying objects and avoiding obstacles; machine vision where a machine understands both static images and video feeds and data is extracted from it and the machine learns from mistakes it has made. He further gave the example of google translate. It can translate any information entered either in text form, audio form and image form. Lyrebird is a software to which if you give few samples of your voice it understands how you speak. If you give it any text it can speak in any language. Someone will not be able to make out the difference as to who is speaking.

Dr. Pashilkar then showed us a video man's creation of humanoid in which some meaningful information is inputted in a robot and then the robot is asked few questions. The robot managed to give answers to most of the asked questions based on the information given. The next video was related to the Boston Dynamics Robot Dog, which can access its surroundings using various sensors and is programmed to avoid obstacles, climb up and down stairs.

He also gave an example that most of the companies around the world are investing in driverless cars. Advantages of these robotic cars would be that they follow all the traffic rules and would be much safer. FA level autonomous vehicles are already in motion. A large proportion of the cars we

use every day have some basic autonomous features like driver assistance, as self-parking. If future the high automation cars would operate with full autonomy and without any human intervention. Further he gave examples of super-computers defeating world champions viz. Garry Kasparov, world chess champion was played against Deep-Blue, a supercomputer made by IBM in 1997. The Google DeepMind Challenge match between Lee Sedol, 18 times world champion versus the AlphaGo [Go - a board game that requires creativity, intuition and strategic thinking], which won all the matches except the fourth match in a five-game match.

Further, Dr. Pashilkar told us about the X-70 47B an unmanned stealth aircraft made by Northrop Grumman. The engines of the aircraft are embedded inside its fuselage. The engines are mostly turbojet and have a compressor near the nose of the aircraft and exhaust at the rear. The exhaust ejects heated air, which is detected as heat signatures by the radar, thus the aircraft loses its stealth capabilities. In addition to support stealth the aircraft is also covered with stealth material which deflect the infrared beams sent by the radar in various directions or absorbs them. The payload is stored inside the aircrafts fuselage to maintain stealth. Future unmanned aircraft can have multiple sensors linked together using artificial intelligence technology. Using artificial intelligence in detecting enemy aircrafts and engaging them would be much faster than a pilot locating the enemy aircraft on radar, positioning his aircraft behind the enemy while assessing his surroundings for other enemy aircrafts before finally engaging. If there are other friendly aircrafts in the area, all the aircrafts can be connected by a secure web of artificial intelligence.

Artificial intelligence accomplishes many things like faster computers, better sensors and improved algorithms but as everything has its limits. As Artificial intelligence is data driven and there is no abstract reasoning the output is completely dependent on input data … “garbage in garbage out”.

This concluded the presentation.

During the question and answer session, Sir Vyankatesh Prabhudesai asked Dr. Pashilkar that in IIT and IISc most courses delivered are related to aerodynamics and propulsion and very few related to ‘controls. In reply, Dr. Pashilkar mentioned that even when he did his B. Tech., they didn’t have a course on ‘controls’. Most of the information about ‘controls’ is delivered in mechanical and chemical

engineering course. The functional use of ‘Controls’ in aircrafts is limited, whereas in a chemical factory where every small part has sensors to monitor them. Dr. Pashilkar mentioned that he learnt ‘controls’ during his Masters.

A student of Aryaan Study Circle asked Dr. Pashilkar quite a few questions on diversified topics. The first question was on the difficulties faced in designing aircrafts with delta wing configuration like the LCA Tejas and variable sweep-wing configuration like F-14A Tomcat. Dr. Pashilkar’ s answer to the question was delta wing aircrafts are not new to the Indian Air Force. Mikoyan-Gurevich MiG-21, Dassault Mirage 2000, LCA Tejas and Dassault Rafale are all Delta wing aircrafts. Smaller fighter aircrafts tend to be delta wing thus making them agile but the downside of this is that they cannot carry much armament. These aircrafts cannot fly long distances and are difficult to be detected. Sweep-winged aircrafts like F-14 Tomcat are usually used for long range bombing missions and can carry heavy loads of payload. Better equipment can be carried in these aircrafts like long-range radar. Furthermore swept-winged aircrafts can take off and land in short distances.

The next question asked by a student of Aryaan Study Circle was, which branch of engineering covers all the interdisciplinary fields requiring making of robots. Dr. Pashilkar replied that the interdisciplinary fields requiring making of robots are covered under mechanical engineering. It is possible to do this under electrical engineering but mechanical also covers topics like ‘controls’ and ‘dynamics’.

Another student of Aryaan Study Circle asked Dr. Pashilkar, the automobile industry has a seven percent contribution to the GDP of the country and wont the introduction of artificial intelligence reduce the production of manually operated cars and won’t the automobile engineers face the problem of unemployment. Dr. Pashilkar replied that every industry will get affected. Industries with repetitive manual labor will get affected the most. The Government has realized this issue and has started many skill development programs. Earlier seventy percent of Indian economy was agricultural and today it is around sixty percent, whereas many other countries have moved on with the IT revolution. If a country must survive it has to be in pace with the world and if it fails to do so there will be unemployment. If people are educated artificial intelligence will create more jobs.

Another student asked Dr. Pashilkar, what would be the scope of using solar energy in commercial and non-commercial aircrafts. The energy produced by solar energy is very less how will they tackle this situation. Dr. Pashilkar answered that the world is moving towards climate change and the aeronautical industry is no exception. There are 7-8-seater aircrafts flying on electrical power. The challenge is energy production. The energy produced by a hydrocarbon fuel cell is much more than that in an electrical battery. Currently methods of using hydrogen as fuel is being developed.

In the end, one of the parents asked Dr. Pashilkar if sentimental analysis had made its way into aerospace application. Dr. Pashilkar answered that the airport authority monitors the pilot's wellbeing, if he is under the influence of unwanted substances before any flight. There is a mandatory rest period of eight hours before any long duration flights, whereas an emotionally unstable military pilots may pose as a threat to himself as well as others and may even pose a threat to peace.

This interactive session gave us an insight into the future of aeronautical industry with emergence of artificial intelligence. On behalf of the students of Aryaan Study Circle, I would like to thank Dr. Abhay Pashilkar for spending his invaluable experience with us, as well as Sir Vyankatesh Prabhudesai for giving us the opportunity to interact with such eminent personalities.

Written By,

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