1st SFTE INDIA CHAPTER SYMPOSIUM

Challenges in Developmental Flight Tests

Virtual Event on

23 & 24 February 2022

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SOCIETY OF EXPERIMENTAL TEST PILOTS - INDIAN SECTION

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Programme

1st SFTE INDIA CHAPTER SYMPOSIUM - PROGRAMME

Date	Session	Time*	Details	Speaker	Session Moderator/ Coordinator
23-Feb-22	Opening Session	1700h	Welcome Address by SFTE-India Chapter President	Wg Cdr K Kalyanraman[M] (Retd)	
		1710h	Keynote Address	Air Mshl CR Mohan [M] AVSM VSM, SMSO, HQ MC, IAF	
	Session-1	1730h - 1800h	Challenges and Lessons Learnt in Developmental Flight Trials of Improved Prototype of Light Transport Aircraft – Saras PT1N	Wg Cdr M Dilli Babu[M] PhD, IAF	Gp Capt Vaibhav Patki[M] (Retd)
		1800h - 1830h	Striking A Balance Between Confirmatory Versus Exploratory Flight Test Philosophy (Experiences from Out of Control Flight Test of IJT Prototype)	Wg Cdr Maheswar Patel[M] (Retd), HAL	
		1830h - 1900h	Tejas Envelope Expansion through Flight Testing	Dr PS Sureshaet al, ADA	
		1900h - 1945h	Dinner Break		
	Session-2	1945h - 2015h	Challenges and Solution: Design and Development of Flight Data Recorder System for Very Light Category Aircraft (VLA)	Wg Cdr RR Senthil Kumar, IAF	Air Cmde S Ghuratia[M] VSM
		2015h - 2045h	Estimation of Gravity Vector and Inertial Velocities with no Dependence on GPS	Kamali C *et al*, NAL	
		2045h - 2115h	Establishing HV Envelope of a Helicopter through Flight Testing - A Qualitative Approach	Wg Cdr Subash P John VM (Retd), HAL	
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	Session-3	2130h - 2200h	**[Invited Talk]** Test Safety, Professional Expertise and Productivity in Flight Test: A Brief History for Tomorrow - Lessons From 4 Decades and 2 "Black Swans"	Jeff "Canman" Canclini[F] LM	Gp Capt M Prabhu[M] (Retd)
24-Feb-22	Session-4	1700h - 1730h	Challenges in Flight Validation and Update of TEJAS Aerodynamic Database using System Identification Techniques	Dushyant Kaliyari *et al*, NAL	Gp Capt Aslam Khan (Retd)
		1730h - 1800h	Flight Testing of Control Laws and Air Data System: Technology Development towards Product Realisation	Rohith M *et al*, HAL	
		1800h - 1830h	Flight Testing the Carrier Landing Control Law Mode for LCA Navy	Anup Goyal *et al*, ADA	
		1830h - 1900h	Challenges and Lessons Learnt in the Assessment of Handling Qualities of an Impaired Fighter Aircraft with Intelligent Reconfigurable Control Laws Using Real-Time Simulation	Kishan S Chowhan *et al*, ADA	
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	Session-5	1945h - 2015h	Challenges in Development and Flight Testing of Air-to-Air Refuelling on "Tejas" Light Combat Aircraft	Gp Capt M Prabhu[M] (Retd)	AVM Arvind Sharma[M], SMSO, HQ CAC, IAF
		2015h - 2045h	Stuff They Didn't Teach Me in Test Pilot School - Lessons Learnt From Developmental Flight Test of LCA (Navy)	Cmde JA Maolankar (Retd) NM	
		2045h - 2140h	**[Invited Talk]** Testing for PIO Susceptibility	William "Bill" Gray , USAFTPS	
		2140h - 2150h	Break		
	Closing Session	2150h	Closing Remarks by SFTE President	Mark Mondt[M]	
		2200h	Presentation of Award and Vote of Thanks by SFTE-India Chapter President	Wg Cdr K Kalyanraman[M] (Retd)	

*Indian Standard Time: GMT+05:30

Web Host: Wg Cdr CM Santosh (Retd.) - +91-9731102211
Co-Host: Wg Cdr Maheswar Patel (Retd.) - +91-9663381943
Queries may please be e-mailed to admin@sfte-india.in

Access Details

- The symposium will be held as a Webinar using 'Zoom' Platform.
- All are Free to Attend. No registration is required.
- Zoom **Direct link/ Login credentials** (different for each day) shall be available at

https://www.sfte-india.in/symposium

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Attendees will NOT be able speak or share their video. They can 'raise a hand' to attract attention or chat with any of the panelist (or host).

All attendees can TYPE their questions using the **Q&A button,** or **Upvote** questions asked by others. The moderator will choose the questions to be put up to speaker based on the relevance as well as the upvotes received.

Panelists (Moderator & Speaker)

The session **Moderator and Current Speaker** will be assigned as panelists by the host manually. There will be a few seconds delay while changeover occurs (After you accept the request from the host, you will be automatically logged out and logged in again)

The panelists will be able to unmute & talk, share video and share their screen.

Panelist will be able to view, upvote or answer Questions raised by Attendees. However, they cannot ask a question in the Q&A window (They are free to talk!!)

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Abstracts

Session 1

23 Feb 2022/ 1730-1900h

Moderator: Gp Capt Vaibhav A Patki[M] (Retd.), SPC5 CSM PMP Enterprise Agile Coach

Presentation 1: CHALLENGES AND LESSONS LEARNT IN DEVELOPMENTAL FLIGHT TRIALS OF IMPROVED PROTOTYPE OF LIGHT TRANSPORT AIRCRAFT – SARAS PT1N

Authors:
Wg Cdr M Dilli Babu[M], PhD, Former Lead Flight Test Engineer – Saras PT1N Flight Trial Team,
Gp Capt UP Singh, Former Lead Test Pilot – Saras PT1N Flight Trial Team, IAF

Abstract:

India's first indigenous Light Transport Aircraft (LTA), Saras, is a 19 seater commuter category aircraft and three versions of prototype aircraft, namely, PT1, PT2 and PT1N were designed and developed by CSIR – NAL. After the mishap of the prototype aircraft, Saras PT2, the other prototype aircraft, PT1, was improved by undertaking various modifications to correct and improve certain shortfalls identified during the initial phase of flight testing on the prototypes PT1 and PT2. The modifications incorporated in Saras PT1N prototype aircraft are, namely, Increased area rudder, new nacelle design, linear flap track, increased area elevator trim tab, aileron control modification, MLG door and belly fairing modification, Environmental control system modification and Stall warning system modification. The overall flight test program of the prototype PT1N was focused towards validating all the modifications while thoroughly evaluating the aircraft performance and HQ and systems performance.

"Predict Test Validate" was followed in true letter and spirit for every test point executed during the trials. Various flight test techniques (FTT) were improvised as standard FTTs were not available/applicable in certain test points. The pusher engine configuration and the retrofit integration of composite propeller warranted improvisation of test techniques and testing aids, due to the uncommon engine configuration and hot gas impingement on composite propeller. The flight test results of Saras PT1N prototype aircraft supported with the results from a wide set of CFD and wind tunnel tests were effectively used and various aircraft and engine mounting configurations were proposed for the LTA new version. A configuration review committee with reps from all stake holding organisations, under co-chairmanship of Dr VK Saraswat and DCAS of IAF, deliberated and reviewed the proposed configurations and design requirements for the final version of the LTA. The committee recommended wing mounted tractor engine configuration for Saras MK2, in contrast to the existing tail mounted pusher engine configuration. The flight trial results of Saras PT1N prototype aircraft was optimally used towards finalisation of configurations and design requirements of airframe and systems for the upcoming Saras MK 2 version of the LTA.

Presentation 2: STRIKING A BALANCE BETWEEN CONFIRMATORY VERSUS EXPLORATORY FLIGHT TEST PHILOSOPHY

Author:
Wg Cdr Maheswar Patel[M] (Retd.)
Senior Flight Test Engineer, Hindustan Aeronautics Ltd, Bengaluru

Abstract:

The present trends and advances in science and technology suggest that sometime in the future all military aircraft will be spin and be departure proof. Till then training requirements for recovery from spin or any other out of control flight event will be an integral part of military pilot's training curriculum. Thus, in the requirements specified for the Hindustan Jet Trainer HJT-36 to fulfill the need of Intermediate Jet Training (IJT) of the Indian Air Force, the requirements for intentionally spinning the aircraft for up to six turns to either side is one of the important decisive factor. The advances in past decades have made flight test of prototype more of a validation or confirmatory task especially in controlled flight regimes. The aircraft behavior in terms of handling and performance is invariably predicted and in flight test, the same is validated or confirmed. Hence, Predict-Test-Validate has invariably been the philosophy of flight testing in controlled flight regimes. When, the same philosophy is adopted for out-of-control non-linear flight regimes such as spin, PDG, PSG with results from ground tests such as Rotary Balance, Force Oscillation and high AOA wing tunnel tests; to some extent, predictions about the aircraft behavior can be made. However, the level of confidence and fidelity of ground simulations are available to a much reduced extent. When deviations between the aircraft behavior from predicted one in the out-of-control flight or in an intentional spin is experienced, major and minor aerodynamic, inertia and control fixes are tried out. In such cases following the Predict Test Validate philosophy by looping back to prediction by repeating the Rotary Balance, forced oscillation and high AOA tests are not always feasible. Hence, a balance between confirmatory and exploratory flight test is necessary in such out-of-control flight test campaigns.

This paper presents the ongoing experiences in flight testing the HJT-36 prototype for stall, departure and spin in various configurations. Despite the six-degree-of-freedom and pilot simulation model not being perfect, the prediction was gainfully utilized to not only undertake flight testing safely and efficiently, but also some minor fixes to the aircraft could be explored successfully to make the aircraft spin behavior some-what acceptable.

Presentation 3: TEJAS ENVELOPE EXPANSION THROUGH FLIGHT TESTING

Authors:
Dr.P.S.Suresh, C.T. Sambandam & G. Radha Krishnan, Aeronautical Development Agency, Bengaluru

Abstract:

The operational capability of home-grown fighter has gone a long way over the decades. With the integration of advance avionic systems as line replaceable units, new armaments and continual design improvements, gave rise to growth in overall mass of the aircraft. Having qualified the prototype version of airframe for its limit and ultimate loads in Main Airframe Static Test (MAST), the demand is to qualify the airframe for its grown mass from technology demonstrator to production standard. In addition, the overswing vertical load factor imposed as agility requirement in implementation of Control Law impacts the structural integrity of airframe. Placed with these challenges, the flight envelope expansion phase through rigorous flight testing combined with validation of strain from high fidelity simulation has been taken up with design groups (Loads, Control law and Stress) and Certification agency (CEMILAC) supported by National Flight Test Center (NFTC). The activities involve a progressive flight by flight clearance approach, right from careful selection of strain gauge monitoring scheme through reserve factor listing from ground test (MAST) experience, drafting of flight test points, Control Law coordination for aircraft handling, successful execution of experimental controlled flights by National Flight Test Center (NFTC), flexible maneuver load simulation on global Finite Element model through flight test point recreation and detailed strain analysis from high fidelity Finite Element local models. The systematic activities led to strain correlation of flight and simulation models on major load path members, acceptable to the certification agency, thereby achieving the complete operational capable flight maneuver envelopes, rendered as 'need of the hour' effort, for the Final Operational Clearance of Tejas.

Session 2

23 Feb 2022/ 1945-2115h

Moderator: Air Cmde Sajiv Ghuratia M VSM, 'Air Cmde Eng H', IAF Headquarters

Presentation 1: CHALLENGES AND SOLUTION: DESIGN AND DEVELOPMENT OF FLIGHT DATA RECORDER SYSTEM FOR VERY LIGHT CATEGORY AIRCRAFT (VLA)

Author:
Wg Cdr RR Senthil Kumar, Flight Test Engineer- Aircraft & Systems Testing Establishment, Indian Air Force

Abstract:

Ultra/microlight category aeroplanes are being used in India by both civil and military agencies. These aircraft are primarily used for basic training in the civil flying clubs. The challenge in Design & Development of light category aeroplanes is to keep the cost low and provide an economically viable product for the user. Many light aircraft manufacturers do not provide FDRs as standard equipment due to the following reasons:

(a) FDRs are not mandated for light category / microlight aircraft as per FAR.
(b) Complexity of tapping data from conventional engine and flight instruments.
(c) Cost and time associated with modification of aircraft with FDR systems.

While, it may not be a requirement as per certification, availability of an onboard Flight Data Recorder will provide valuable data for incident/accident investigation. The need for such a system is very much essential for ensuring flight safety.

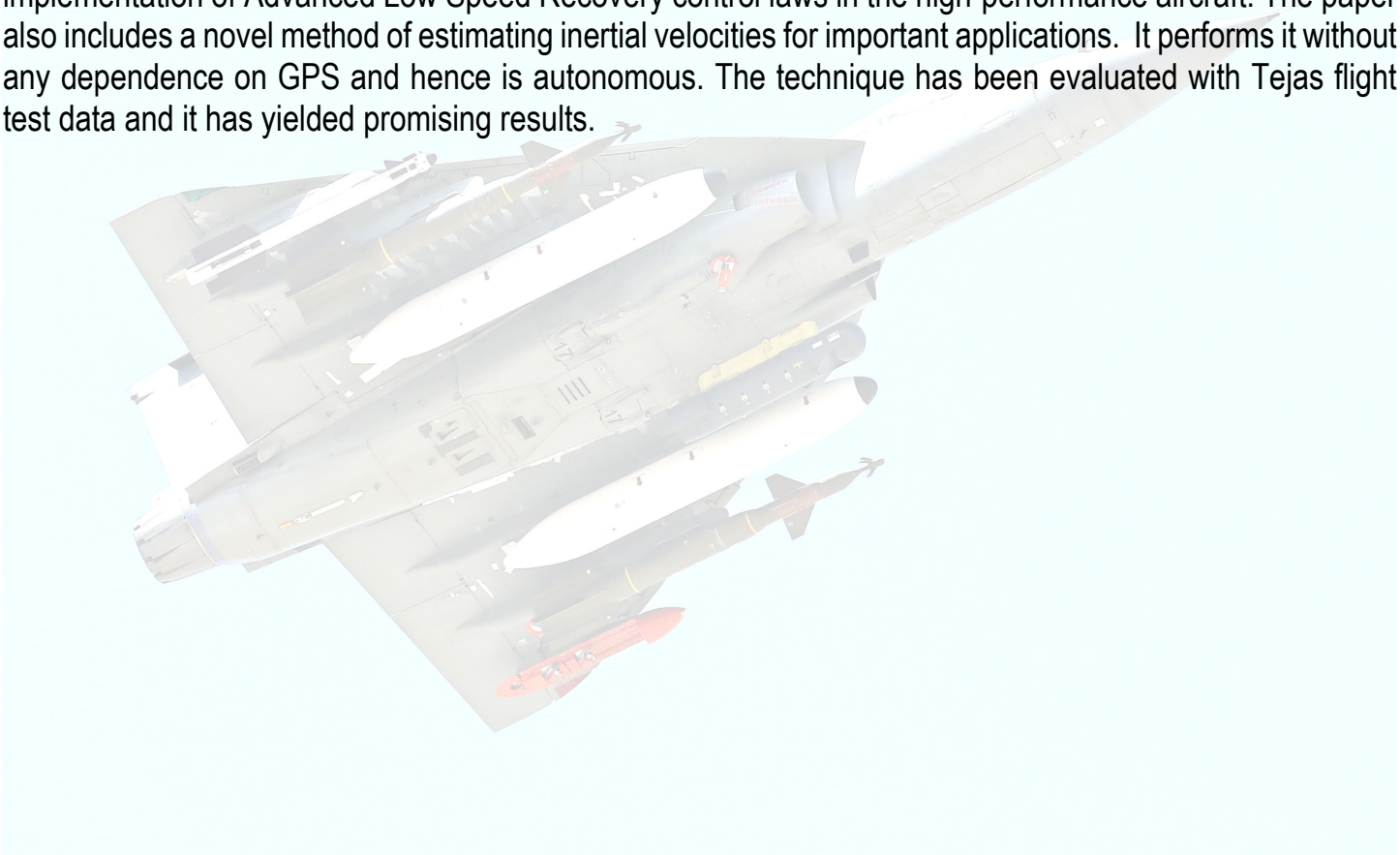
The author has made an effort to address the issue of Flight Data Recorder system for microlight category aircraft and suggest certain solutions implementable in the D&D stage. The Pipistrel SW-80 microlight aircraft available at ASTE was utilised for conducting project feasibility studies. The aircraft did not have an onboard Flight Data Recorder, it has provision for recording only the GPS tracks which is insufficient for debrief and accident/incident analysis. The initial survey on the aircraft revealed that the Pipistrel aircraft engine and flight instrumentation systems were based on Controller Area Network (CAN) protocol-based communication. The CAN is a widely used automobile protocol which has found increased acceptance recently in civil and military aircraft systems. The Pipistrel virus being a microlight category aircraft, the conventional instrumentation for flight data recording is not feasible due to space and weight constraints. All necessary Flight and Engine data were found to be available on the CAN bus. Therefore, it was decided to develop a modification scheme based on the existing CAN bus protocol. Extensive studies were undertaken by the team at Flight Test Lab to understand the protocol and arrive at a workable solution.

Presentation 2: ESTIMATION OF GRAVITY VECTOR AND INERTIAL VELOCITIES WITH NO DEPENDENCE ON GPS

Authors:
Dr Kamali C and Shikha Jain, Scientists - National Aersopace Laboratory
Dr Amitabh Saraf, Group Director IFCS, CLAW team, Aeronautical Development Agency

Abstract:

This paper discusses development of a technique to estimate gravity vector and inertial velocities within DFCC. The gravity vectors can directly be used for gravity compensation in the augmented unstable high-performance aircraft, Further, the roll and pitch attitudes computed from gravity vectors can be used for the implementation of Advanced Low Speed Recovery control laws in the high-performance aircraft. The paper also includes a novel method of estimating inertial velocities for important applications. It performs it without any dependence on GPS and hence is autonomous. The technique has been evaluated with Tejas flight test data and it has yielded promising results.



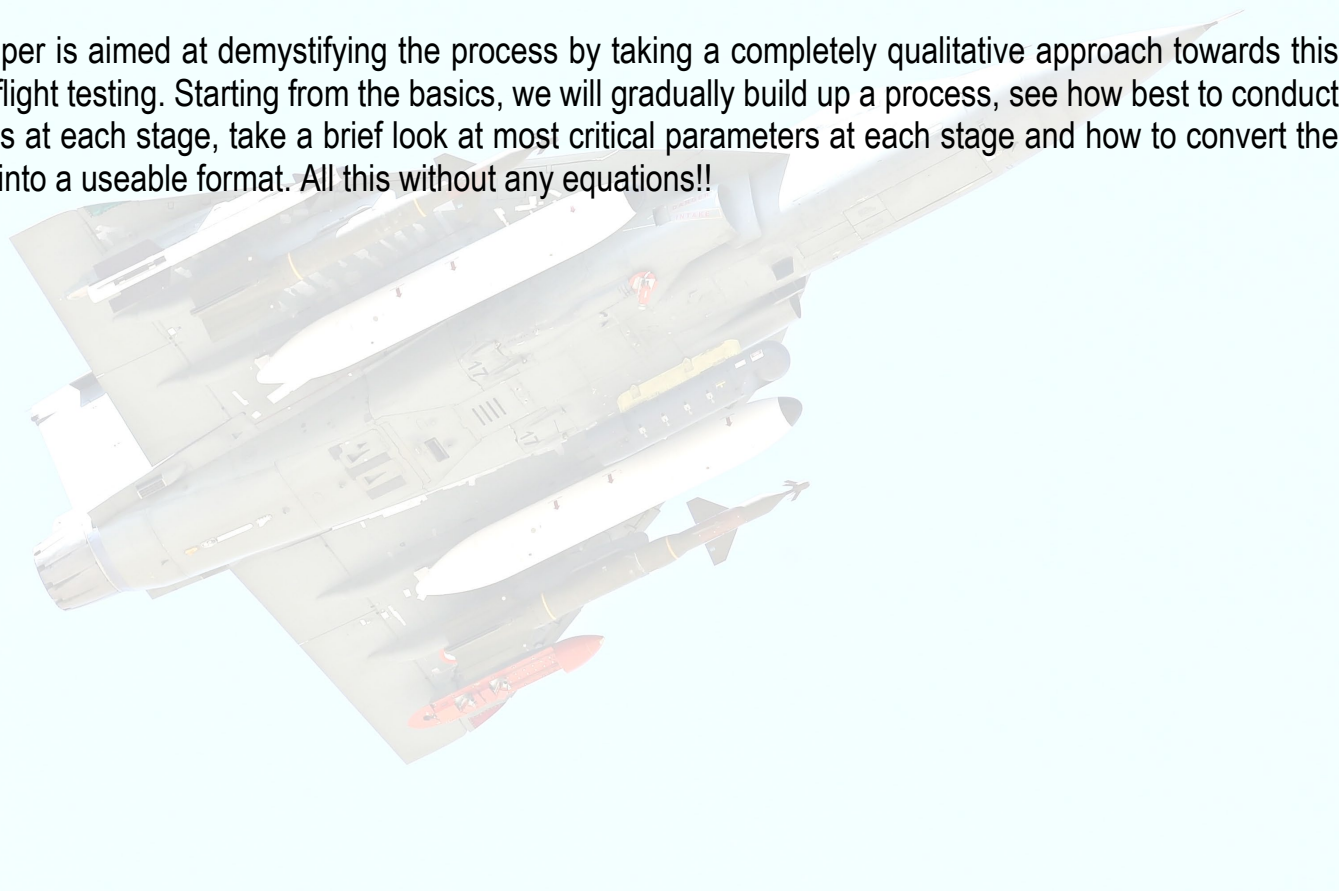
Presentation 3: ESTABLISHING HV DIAGRAM: A QUALITATIVE APPROACH

Author:
Wg Cdr Subash P John VM (Retd), Test Pilot (Rotary Wing),
Hindustan Aeronautics Ltd.

Abstract:

Every helicopter has a regime of height speed combination that the pilots are taught to avoid. This is the height velocity diagram or 'dead man's curve'. The curve is specific to a helicopter and provides the height speed combination from which a safe autorotative recovery may not be possible. Establishing height velocity diagram for a new helicopter is one of the most challenging part of flight testing.

This paper is aimed at demystifying the process by taking a completely qualitative approach towards this part of flight testing. Starting from the basics, we will gradually build up a process, see how best to conduct the tests at each stage, take a brief look at most critical parameters at each stage and how to convert the results into a useable format. All this without any equations!!



Session 3

23 Feb 2022/ 2130-2200h

Moderator: Gp Capt M Prabhu [M] (Retd), Vice President SFTE-India Chapter,
Group Director (Flight Test Engineering), National Flight Test Centre, Aeronautical Development Agency, Bengaluru

Invited Talk: TEST SAFETY, PROFESSIONAL EXPERTISE AND PRODUCTIVITY IN FLIGHT TEST: A BRIEF HISTORY FOR TOMORROW - LESSONS FROM 4 DECADES AND 2 "BLACK SWANS"

Speaker:
Jeff "Canman" Canclini [F], Lockheed Martin Aeronautics FTE Fellow,
Society of Flight Test Engineers Fellow, SFTE Board member & Treasurer

Brief:

Some of the major challenges for future developmental flight testing revolve around increasingly complex, autonomous and software intensive systems. This paper will look back over the author's four decades in aerospace and flight testing to glean lessons learned and highlight emerging methodologies and technologies to help successfully confront these challenges. Areas that will be discussed are risk mitigation, FTE/Test Pilot expertise and test productivity, all which are key to helping ensure product robustness.

About the Speaker:

Jeff "Canman" Canclini has 44 years in the aerospace industry including 37 years in flight test and flight operations. After completing his master's in mechanical engineering from the University of California, Davis, Jeff joined NASA as a design engineer. In 1979 he left NASA to complete F-4 Phantom flight training. After completing WSO flight training, Jeff began work as Electronic Design Engineer and Flight Test Engineer while simultaneously flying F-4's in the USAF reserves. Jeff is a distinguished graduate of USAF Test Pilot School class 86A, receiving the "R.L. Jones Trophy" as the top Navigator/FTE graduate. In 1988, Jeff transferred to the Navy Reserves to begin flying F-14 Tomcats, later serving two commanding officer tours with the Naval Air System command. During this period Jeff was also involved in flight tests with General Dynamics (later Lockheed Martin) on the A-12 Avenger and F-16 including the Super Viper for the MMRCA program. In 2013 he joined Lockheed Martin's F-35 flight test program as the lead mission systems FTE for test planning, later serving as the F-35 International Flight Operations Manager in Italy and Japan until his retirement in Dec 2021.

Jeff is an SFTE Fellow and Lockheed Martin Fellow (Emeritus). He is currently a member of the SFTE Board of Directors. He holds a commercial multi-engine pilot rating and has accumulated over 3300 hours in 26 fixed and rotary wing aircraft. He is the author of several papers on varied subjects.

Session 4

24 Feb 2022/ 1700-1900h

Moderator: Gp Capt Aslam S Khan (Retd.), Operations Director, A&D Engineering R&D Services, HCL Technologies Ltd, Bengaluru

Presentation 1: FLIGHT VALIDATION AND UPDATE OF LCA TEJAS AERODYNAMIC DATABASE USING SYSTEM IDENTIFICATION TECHNIQUES

Authors:
Dushyant Kaliyari, Khadeeja Nusrath TK & Jatinder Singh, Scientists at CSIR-National Aerospace Laboratories, Bengaluru
Dr Vijay V Patel & Dr Amitabh Saraf, Scientists at Aeronautical Development Agency, Bengaluru

Abstract:

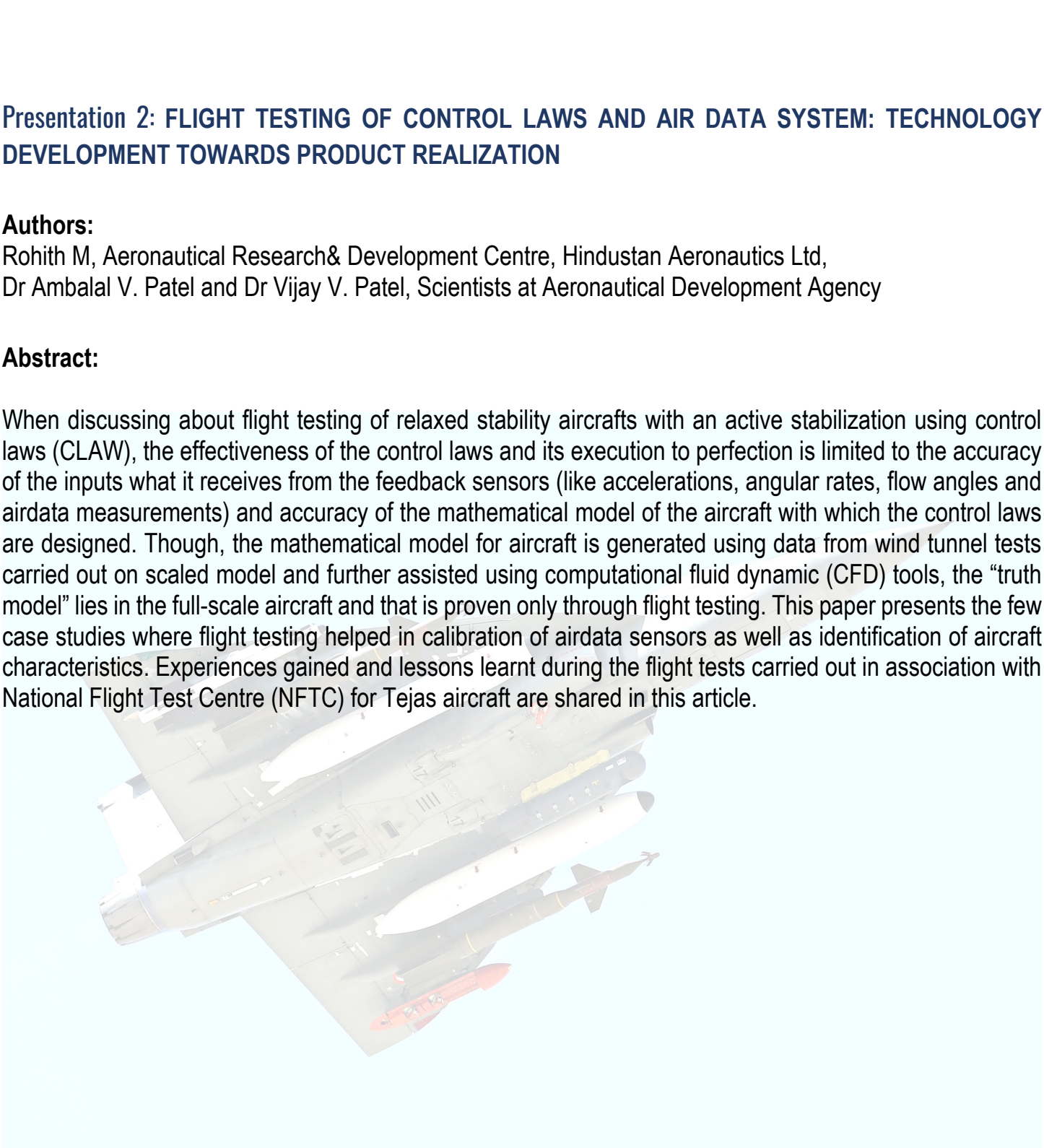
For a high-performance aircraft, an accurate aerodynamic model is required for various applications such as flight envelope expansion, high fidelity ground-based simulators and control laws design. Validation and update of the aerodynamic database of Tejas aircraft were carried out using system Identification techniques applied to flight test data. An incremental model update approach, based on aerodynamic coefficient matching, was used to update the aerodynamic database towards the Final Operational Clearance of LCA Tejas. The updated aerodynamic database was validated by matching the nonlinear simulation predictions with the flight measured responses. This paper highlights the critical issues encountered during the database validation and update process through System Identification techniques, such as optimal control input design for flight testing at higher angles-of-attack, sensor characterisation in the presence of process noise, discrepancies in the baseline aerodynamic model structure, real-time monitoring for safe envelope expansion and store grouping techniques to reduce the flight test effort.

Presentation 2: FLIGHT TESTING OF CONTROL LAWS AND AIR DATA SYSTEM: TECHNOLOGY DEVELOPMENT TOWARDS PRODUCT REALIZATION

Authors:
Rohith M, Aeronautical Research& Development Centre, Hindustan Aeronautics Ltd,
Dr Ambalal V. Patel and Dr Vijay V. Patel, Scientists at Aeronautical Development Agency

Abstract:

When discussing about flight testing of relaxed stability aircrafts with an active stabilization using control laws (CLAW), the effectiveness of the control laws and its execution to perfection is limited to the accuracy of the inputs what it receives from the feedback sensors (like accelerations, angular rates, flow angles and airdata measurements) and accuracy of the mathematical model of the aircraft with which the control laws are designed. Though, the mathematical model for aircraft is generated using data from wind tunnel tests carried out on scaled model and further assisted using computational fluid dynamic (CFD) tools, the “truth model” lies in the full-scale aircraft and that is proven only through flight testing. This paper presents the few case studies where flight testing helped in calibration of airdata sensors as well as identification of aircraft characteristics. Experiences gained and lessons learnt during the flight tests carried out in association with National Flight Test Centre (NFTC) for Tejas aircraft are shared in this article.



Presentation 3: FLIGHT TESTING THE CARRIER LANDING CONTROL LAW MODE FOR LCA NAVY

Authors:
Anup Goyal, Abhilash PM, Gaurav Kumar, Dr Amitabh Saraf, Scientists at Aeronautical Development Agency, Bengaluru
Cdr Ankur Jain (Retd.), Test Pilot, NFTC, Bengaluru

Abstract:

Carrier landing is considered as one of the most demanding aviation tasks. In the arrested landing scenario, the aircraft hook has to touchdown in a very small region on the landing runway of a moving carrier ship to catch the arrestor wire. The aircraft speed should be as low as possible to minimize the arresting loads on the aircraft structure.

The standard practice that has proved well over the years is to have a smooth, stabilized, constant speed trajectory of the aircraft along the prescribed glide slope all the way to touch down on the carrier without any flare. The ability to change flight path with minimal change in aircraft pitch angle is a desirable feature as well to prevent any undesired cable engagement. The landing mode of the LCA Airforce variant was evaluated in the simulator for landing on the carrier and it was felt necessary to augment the design to reduce pilot workload during landing. Carrier landing task has three main aspects: maintain the aircraft speed, maintain the desired glide slope and minimize the lateral deviations. Pilot uses pitch stick, roll stick and throttle to make the aircraft follow the desired approach trajectory. In a speed stable aircraft, the task becomes a little simpler, because aircraft naturally tries to maintain approach speed if the elevator position is kept nominally fixed, and throttle inputs directly change the aircraft flight path. So, pilot can make the aircraft fly at desired flight path using only throttle inputs and the pitch stick activity is minimized. This is traditionally called as flying the backside technique.

LCA is not an inherently speed stable aircraft. So, a new control law mode was conceptualized for LCA Navy to mimic the speed stable behavior. This essentially required a potent feedback to the pitch control surface to maintain a desired approach AOA (and as a result maintain speed). The mode was hence named Approach Alpha Hold Controller (AAHC). In this mode pilot could fly effectively with hands off the pitch stick and make flight path corrections with engine throttle alone.

This paper describes the AAHC mode, its different phases of evolution, various pilot evaluations carried out in the simulator and in flight at the shore-based test facility (SBTF). The mode was found very useful and was extensively used by pilots during the different phases of trials of LCA Navy on INS Vikramaditya.

Presentation 4: CHALLENGES AND LESSONS LEARNT IN THE ASSESSMENT OF HANDLING QUALITIES OF AN IMPAIRED FIGHTER AIRCRAFT WITH INTELLIGENT RECONFIGURABLE CONTROL LAWS USING REAL-TIME SIMULATION

Authors:
Kishan S Chowhan, Scientist , Aeronautical Development Agency, Bengaluru
Dr Hemendra Arya, Professor, Indian Institute of Technology, Bombay
Dr Girish S Deodhare, Director General Aeronautical Development Agency, Bengaluru
Wg Cdr M Dilli Babu[M], Flight Test Engineer, Indian Air Force

Abstract:

The extreme structural damage/malfunction scenario such as partial loss of wing or vertical fin, jamming, or partial loss of control surface(s) are not catered in flight control laws of conventional Fly-By-Wire aircraft and therefore have led to loss of control of aircraft resulting in fatal accidents. It may be noted that these cases are never flight-tested because of the dangers involved.

This paper brings out the challenges and lessons learnt during the assessment of Handling Qualities (HQ) evaluation during the development of Intelligent Reconfigurable Control laws (RICL) to exercise control of a fighter aircraft model with a certain set of impairment/partial damage in a real-time simulator.

Reconfigurable flight Control laws were developed to recover a conventional FBW aircraft under loss of wing or vertical tail scenarios and the same was evaluated for different flight phases such as Air combat, Cruise, etc.to obtain Cooper-Harper Ratings with a set experimental test pilots using real-time simulation.

Session 5

24 Feb 2022/ 1945-2140h

Moderator: Air Vice Marshal Arvind Sharma[M], Senior Maintenance Staff Officer, HQ Central Air Command, IAF

Presentation 1: CHALLENGES IN DEVELOPMENT AND FLIGHT TESTING OF AIR-TO-AIR REFUELLING ON "TEJAS" LIGHT COMBAT AIRCRAFT

Author:
Gp Capt Malteesh Prabhu (Retd.)[M], Group Director (Flight Test Engineering)
National Flight Test Centre, Aeronautical Development Agency, Bengaluru

Abstract:

The Indian Light Combat Aircraft (LCA) is integrated with a Probe and Drogue refuelling system for Air-to-Air Refuelling. The probe was integrated late in the development phase of the aircraft, well after Initial Operational Capability was achieved. Being a small aircraft, there were challenges in design of the fuel system for Air-to-Air refuelling. The digital flight control and air data systems also needed modifications to ensure safe refuelling operations.

This paper traces the development of air-to-air refuelling system on the LCA. It presents the challenges faced, development path and flight test results. Extensive analysis of flight test data and video were used to ascertain task performance against Handling Qualities (HQ) performance requirements. A video processing algorithm was developed by the National Flight Test Centre (NFTC) for this purpose.

In summary, HQ during refuelling was assessed as Level-1 for all flight conditions and configurations. However, differences in HQ ratings were noticed between drogue tracking and AAR hook up tasks. Likely reasons for the same are discussed. The aircraft fuel system performance was good except for one instance of overpressure in fuel tank at the very low-speed end of refuelling envelope and at high AUW, which was later addressed by a hardware modification.

Presentation 2: 'STUFF THEY DIDN'T TEACH ME IN TEST PILOT SCHOOL' - LESSONS LEARNT FROM DEVELOPMENTAL FLIGHT TEST OF LCA (NAVY)

Speaker:
Commodore JA Maolankar (Retd.) NM, Test Pilot

Brief:

The Technology Demo programme of the Light Combat Aircraft (Navy), undertaken by the Aeronautical Development Agency and Indian Navy, culminated in Jan 2020 with the Initial Sea Trials of the aircraft onboard the aircraft carrier INS Vikramaditya. This was preceded by a unique flight test campaign over the preceding two years.

The Tech Demo flight test campaign was characterised and shaped by the magnitude of the field of endeavor (viz. Carrier Suitability Testing), its novelty for this country and the extremely lean flight test team utilized. Even so, the dictates of shipboard operation and the involvement of vital national assets (the sole aircraft carrier), mandated that the highest standards of global best practices and caution were achieved. This necessitated going well beyond the classical flight test concepts taught in Test Pilot School and also adoption of different 'persona' from that which is often advocated amongst test crew.

This talk will seek to present some of the methods adopted and lessons learnt during this programme. It will cover the following topics: -

- Short introduction to STOBAR operation from an aircraft carrier
- A quick primer on Carrier Suitability flight testing and inherent differences from "Land Based Aircraft" testing
- Mandates of safety led to adoption of "Real-time" progression of flight testing utilizing multiple hot refuelling.
- "Skill" remains a primary factor in Carrier suitability test point execution.

Invited Talk: TESTING FOR PIO SUSCEPTIBILITY

Speaker: William “Bill” Gray, Chief Test Pilot, US AF Test PIlot School

Brief:

The talk would aim to cover the following areas:

- Definition of PIO,
- Flight testing for PIO in general,
- Assessing PIO and mitigations,
- Flight testing versus simulation testing - some general concepts.
- Addressing digital systems. From a pilot-in-the-loop standpoint, a digital FCS doesn’t change how pilots work. On the other hand, a digital FCS can be used to create control systems that can cause problems for pilots that are more accustomed to compensating for unaugmented aircraft responses.

About the Speaker:

Wiliam Gray graduated from USAFTPS as a test pilot in 1991. He qualified as a test pilot in the F-15 and T-38, and was the chief pilot for the flight evaluation of seven aircraft that led to the selection of the T-6 Texan II primary trainer. He was later selected as a developmental test pilot for the F-117 Nighthawk. Gray continued to advance the art of flight test as the chief of Test Safety at the Air Force Flight Test Center at Edwards where he was responsible for safety oversight of over 100 test projects per year. His safety regulations formed the basis of those still used today.

After retiring from the Air Force, Gray joined the TPS staff as a civil servant and has been instrumental in producing both flight test professionals and flight test techniques. His military and civilian flying career has encompassed about 6,000 flight hours in nearly 100 different aircraft types and is marked by significant contributions to handling qualities test techniques and flight test safety, along with over a dozen publications supporting the flight test community.

As the chief test pilot at TPS, he oversees flight curriculum development and provides instruction to students and instructors in both aircraft and in the classroom. He also mentors student test teams conducting their real-world test management projects to receive their master’s degrees.

Note: The complete proceedings shall be published on SFTE India Chapter Website after completion of the Symposium