ADA

Aeronautical Development Agency

SELF RELIANCE IN COMBAT AIRCRAFT DEVELOPMENT

TEJAS

THE INDIAN LIGHT COMBAT AIRCRAFT

Contents

Programmes

Technologies

"AIR WING ON A CARRIER"

ADA

ADA as a nodal organisation for combat aircraft development has synergised and developed strategic capabilities in various disciplines with identified partners for realising number of advanced technologies and final products for the Users. This has been achieved in association with HAL as principal partner and with DRDO Laboratories, CEMILAC, DGAQA, CSIR Labs, PSUs, Private sector agencies, IAF, IN and Academic Institutions as major partners who have actively participated and contributed towards success of this national venture.

"Tejas" the Premier programme undertaken by ADA with significant contributions by participant organizations is a triumphant venture culminating in the induction for operations by IAF. This has led to the successful formation of 'Flying Daggers', No. 45 Squadron of IAF.

Three other variants of the LCA Programme, viz., Air Force Trainer, Navy Trainer and Navy Fighter are under flight test. Mk2 versions of Air Force and Navy are Medium weight aircraft with higher thrust engine and improved mission and point performance is in advanced stage of design.

Advanced Medium Combat Aircraft (AMCA) a Fifth Generation, Medium Weight, Multi-Role, Twin Engine Stealth Fighter Aircraft is under development. The configuration incorporates several advanced technologies like external geometric profiling, serpentine air intake, conformal weapon bay, radar absorbing materials and coatings to enhance its stealth capabilities.

Tejas is a Light Combat Aircraft (LCA) configured with a single engine, compound delta wing, relaxed static stability and advanced digital fly-by-wire control system, which makes it an agile war machine. Tejas is the smallest and lightest multirole all-weather supersonic fighter of its class.

- The fly-by-wire flight control system enables excellent handling qualities, making it a Pilot's delight. The advanced glass cockpit enhances situational awareness and aids in decision support for all missions.
- It is equipped with Computerized Utility Management System and Health & Usage Monitoring System which eases maintenance
- Features for Beyond Visual Range Combat and Air to Air Refueling Capabilities

The Air Force Trainer is an operational 2-Seater aircraft. Two prototypes have been built and are nearing operational clearance. The Naval Fighter and Trainer variants are built to operate on aircraft carriers of the Indian Navy. As part of qualification for carrier suitability, launch capability from a ski jump replicated in the Shore Based Test Facility (SBTF) at INS Hansa, Goa, has been successfully demonstrated. ADA has joined select club of countries including US, France, UK, Russia & China to have capability to produce aircraft which can operate from aircraft carrier.

LCA AF FIGHTER

Performance

• Max speed	Supersonic at all altitudes
• Service Ceiling	50,000 ft
• 'g' Limits	+8/-3.5

Dimensions

• Span	08.20 m
• Length	13.20 m
• Height	04.40 m

Weight

• Take-off Clean	10330 kg
• Empty	7040 kg
• External Stores	3910 kg

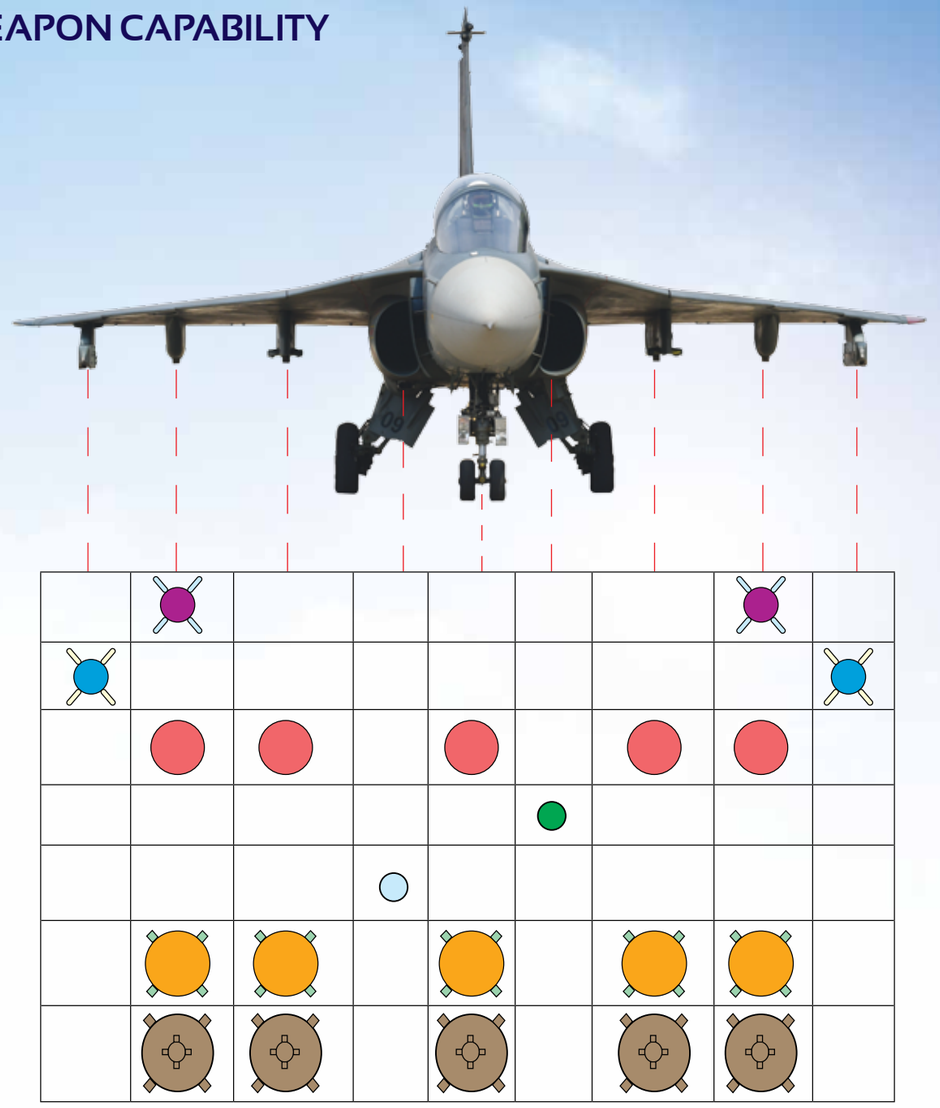
Power Plant

GE - F404 - IN20

Special Features

- ¤ Compound Delta Planform
- ¤ Relaxed Static Stability
- ¤ Composite Structure
- ¤ Fly-by-wire Flight Control
- ¤ Computer based monitor and control of Electro Mechanical Systems
- ¤ Glass Cockpit
- ¤ Multi-Mode Radar
- ¤ Air to Air Refueling
- ¤ Beyond Visual Range Combat Capability

WEAPON CAPABILITY



External Stores

- Beyond Visual Range (BVR) Missile
- Close Combat Missile (CCM)
- Bombs
- Laser Guided Bomb (LGB)
- Gun
- DROP Tanks
- Laser Designator Pod (LDP)

LCA AF FIGHTER CAPABILITIES

- Sensors -INS GPS based Navigation/ Weapon Aiming Suite, Multi-Mode Radar, Litening LPD, HMDS,VOR/ILS, TACAN, IFF, RWR & CMDS
- MMR for Air to Air, Air to Sea, Air to Ground with Weather RADAR Capabilites
- Operable in extreme Hot/Cold Weather Conditions
- Air to Air Refueling from IL-78 tanker
- Hot Refueling Capabilities
- GSh-23 Gun

3DT carriage for better endurance

- Advanced Auto-Pilot along with Critical Altitude Recovery, Disorientation Recovery and Gust Alleviation Features
- Day/Night Operations
- 'g' limits: +8/-3.5 'g'

Air to air refueling with IL-78 tanker

Formation flying of Tejas aircrafts

Close combat missile-R73 E firing

High altitude operations at Leh

LCA AF TRAINER CAPABILITIES

- Operational Type Trainer and 2-Seater
- Similar capabilities as the Fighter

LCA AF MK2

It is a state of art multirole supersonic fighter with delta wing and close coupled canard with following features:

- Long range and endurance:
  - Inflight refuelling Capability
  - On Board Oxygen Generation System (OBOGS) to supply oxygen for unlimited duration
- High Payload Carrying capacity with heavy stand off weapons
- Multirole Capabilities:
  - Beyond Visual Range (BVR) missiles carrying capability
  - Air-to-Air & Air-to-Ground Missiles
  - Heavy Precision Guided Weapons with stand-off ranges more than 100 km
- Unified Electronic Warfare Suite (UEWS) with Radar Warning Receiver (RWR) and Jammers
- Netcentric warfare Capabilities
- Quick turn around and role change
- Advanced Avionics with Large Area Display (LAD) and Smart Head Up Display (HUD)
- Fly-by-Wire Flight Controls with Upgraded Digital Flight Control Computer and Indigenous Actuators
- Advanced Sensors:
  - Active Electronically Scanned Array (AESA)
  - Infra Red Search & Track (IRST)
  - Multi Sensor Data Fusion capability

Weight

- Max. All Up Weight : 17500 Kg
- Payload : 6500 Kg

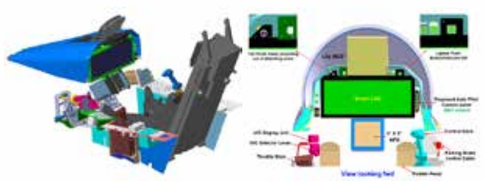
Power Plant

- GE-F414-INS6

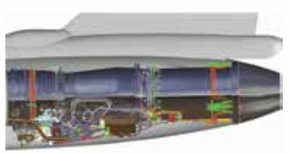
Performance

- Service Ceiling : 50000 ft
- 'g' Limits : +9/-3.2
- Max Speed : 1.8 Mach

IRST and AESA Radar



Smart Cockpit



Higher thrust Engine

FUTURE OF AIR POWER LCA AF MK2

Networked Fighter

- Advanced secure SDR enabled tactical D/L
- Real time transfer of data and imagery
- Secure weapons guidance using MDL
- Teaming possible in future

INTEGRATED SELF PROTECTION

- MAWS, IRST, RWR, LBJ and CMDS integrated to provide 360° spherical coverage

OMNI ROLE FIGHTER

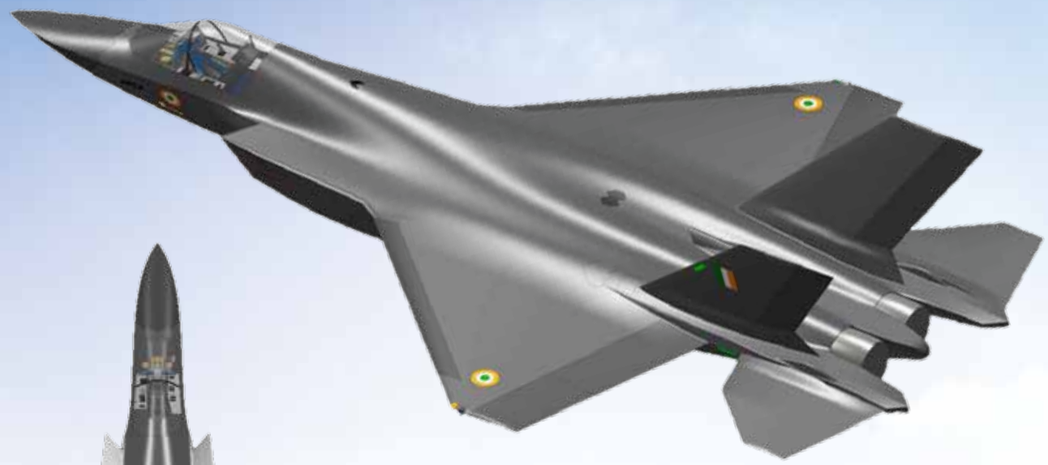
- Carriage of wide variety in (11 Stn)
- Simultaneous engagement of A-A and A-G Targets

ADVANCE COCKPIT

- Sensor Fusion enabled tactical scenario
- Smart cockpit with Large Area Display

ADVANCED MEDIUM COMBAT AIRCRAFT (STEALTH FIGHTER)

AMCA is a Fifth Generation, Medium Weight, Multi-Role and Twin Engine Fighter Aircraft with a swing role capability. The aircraft has trapezoidal wings, all moving Horizontal tails and twin canted vertical tails.



BALANCED DESIGN

Trade - off between aerodynamics, stealth and structure for achieving the balanced design. Enhanced lethality and survivability by means of stealth and electronic warfare capabilities

The Advanced technologies that confer stealth capabili$es are DSI with Serpen$ne Duct, Internal Weapon Bay (IWB), Radar Absorbing Material (RAM) and Conformal Antennae. The stealth mission enables the Suppression of Enemy Air Defence (SEAD), Destruc$on of Enemy Air Defence (DEAD) and precision strike.

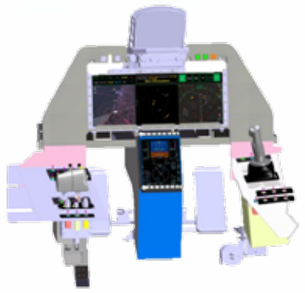
Features

- Stealth Air Frame
- Pilot Vehicle Interface
- Sensor Data Fusion
- Passive Sensors
- Low Emission
- AESA RADAR
- EW Suite
- Decision Aids

- Net Centric Warfare
- Internal Carriage of weapons/stores
- DSI Air Intake with Serpentine Duct
- Advanced Integrated Sensor Suite
- 360° Enhanced Situation Awareness
- Conformal Antennae/Apertures
- IVHM
- Conformal Antennae

COCKPIT

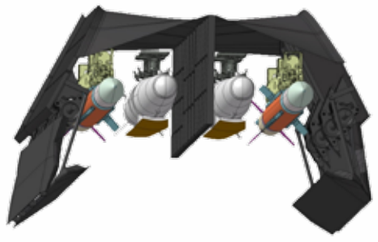
AMCA cockpit is equipped with state of art technology for pilot vehicle interface.



COCKPIT Features

- SErgonomically designed Cockpit Layout
- All Round Visibility
- ITO Coated Single Bubble Canopy
- Minimum physical switches
- Large area display (LAD)

INTERNAL WEAPON BAY



LCA NAVY Mk1

Indigenously designed and developed Naval Fighter Aricraft with STOBAR (Short Take-off But Arrested Recovery) capability for Carrier borne operations in Air defence and Anti-ship Strike role. Compound delta wing, relaxed static stability and advanced digital fly by wire control system makes it an agile war machine.

Shore Based Test Facility (SBTF) A unique state of the art facility, replicating an aircraft carrier, developed by ADA at INS Hansa, Goa, first in Asia and third in the world

Features

- 14° Parabolic Ski Jump Ramp
- Restraining Gear System
- Arresting Gear System
- Optical Landing System

Test facility enhanced for precision flight testing with

- Photogrammetry System
- Telemetry & Monitoring Station


Ski-Jump

Special Features

- Airframe capable to withstand severe arrested landing loads
- High strength Telescopic landing gear for high sink rate landing
- Arrester Hook System for landing within 90 meters deck run
- LEVCON, a control surface for approach speed reduction during landing on carrier
- Special Control LAW for Ski-Jump take-off & Arrested Landing


Take-off from INS Vikramaditya


Arrested landing on INS Vikramaditya

- On-board equipments designed and tested for severe arrested landing shock
- 19° HUD & Nose Droop provides enhanced field of view for carrier landing
- 72° Nose Wheel Steering for maneuvering on carrier deck
- In-flight Fuel Jettisoning capability for quick recovery for emergency landing
- Hot refueling capability to increase turnaround service

Achievements


Ski-Jump Take-off


Night Ski-Jump Take-off


High Sink Rate Landings

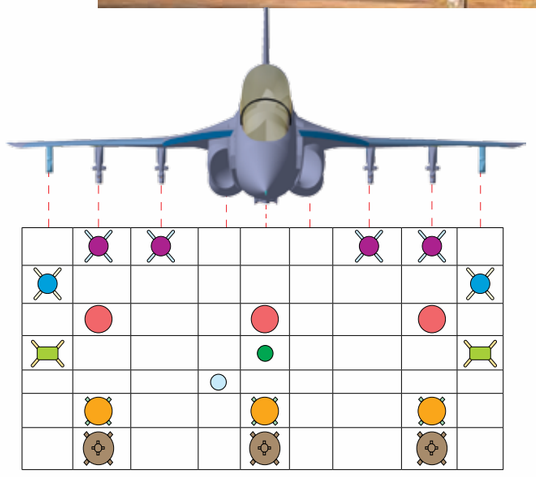

72° Nose Wheel Steering

- Successfully demonstrated Carrier Compatibility by Arrested Landing and Take-off from INS Vikramaditya
- Demonstrated Ski-Jump Take-off and Arrested Landing in Day and Night at SBTF
- Ski-Jump Take-off in adverse headwind conditions vis-a-vis Carrier environment demonstrated successfully
- Hands-free Take-off control law mode proven successfully
- Demonstrated High Sink Rate Arrested Landing at SBTF
- Hot refueling demonstrated and being carried out as routine activity during each flight
- Fuel jettisoning demonstrated successfully. LCA-Navy is the first Indian Aircraft with this capability
- Data link functionality demonstrated with Sea Harrier


Hot Refueling


Ski-Jump Take-off from SBTF


Arrested Landing at SBTF



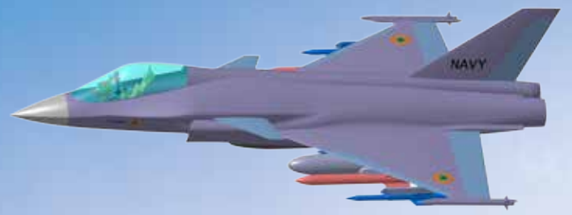
Mission capability

- Air superiority with CCM, BVR, Gun and SPJ
- MMR with Air-to-Air, Air-to-Ground and Air-to-Sea capability
- Data link functionality with Ground and Air stations
- RWR and CMDS functionality

External Stores

BVR · Gun · Bombs
CCM · Drop Tank · LGB
SPJ · LDP

TWIN ENGINE DECK BASED FIGHTER (TEDBF)



Roles:

- Combat Air Patrol
- Deck launch interception
- Air to Air combat
- Anti-ship strike
- Maritime strike
- Land attack strike
- Escort jamming
- Buddy refueling

Specs:

Max Mach no	:	1.6
Service ceiling	:	60,000 ft
'g' limits	:	+8g/-3g
MTOW	:	26 ton
Span	:	11.2 m
Folded wing span	:	7.6 m
Total length	:	16 m

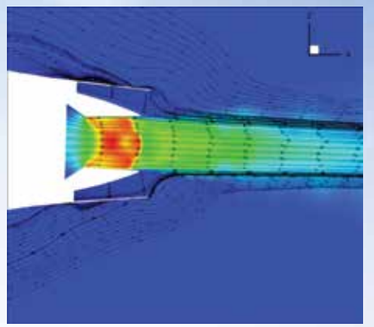
Specifications

Medium weight carrier based fighter aircraft
Compatible for operations from **INS Vikramaditya & IAC1** carriers
Caters for **IN's long term** carrier fighter operational requirements
Optimised for **STOBAR** operations
Primary weapon fit with **indigenous weapons**
Optimised for **carrier ops** and higher **mission/combat performance**
Slated for induction by Indian Navy by **2031**
Advanced sensors & Avionics suite integration
Propulsive thrust from **2 nos. of GE F414 INS6** engines
Primarily conceptualised for Air to Air & Anti-ship roles
Comprehensive carrier interfacing

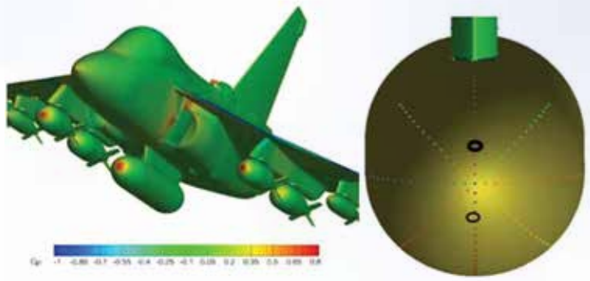
ADVANCED TECHNOLOGIES FOR NEXT GENERATION MANNED & UNMANNED COMBAT AIR VEHICLES

In the past decade Aeronautical Development Agency has led the development of advanced technologies for futuristic combat air vehicles. The major areas of focus in this field are:

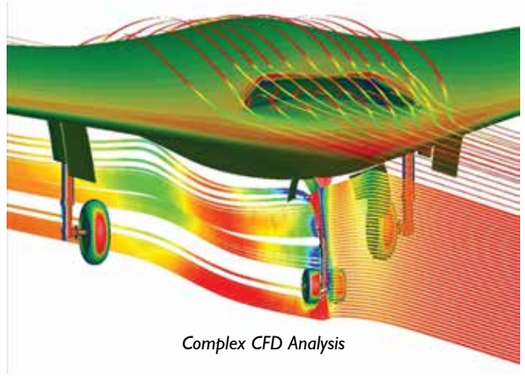
- Genetic Algorithm based Multi Disciplinary Optimization framework
- High-Fidelity Computational Fluid Dynamics (CFD) Code development
- High-Fidelity Computational Electro-Magnetics (CEM) Code development
- Serpentine Intake Design
- 2-D Shielded Exhaust Design
- Thrust Vector Control (TVC) Development
- Very Low Observability (VLO) Planform Design
- Radar Absorbing Materials (RAM) Development
- Radar Absorbing Structures (RAS) Development
- Radar Absorbing Paints (RAP) Development
- Automation of Structural Design & Analysis
- Internal Weapon Bay Design
- Autonomous Take-Off and Landing (ATOL) System development
- Automatic Carrier Landing System (ACLS)
- Flush Air Data System (FADS) development
- Controllable Flight of Flying wing with no Vertical Tail



TVC



FADS on LCA Drop Tank



Complex CFD Analysis

AERODYNAMICS & PERFORMANCE

Drop Tank Jettison Simulation for LCA AFMk2

Internal Store Separation Simulations from Weapon Bay of AMCA

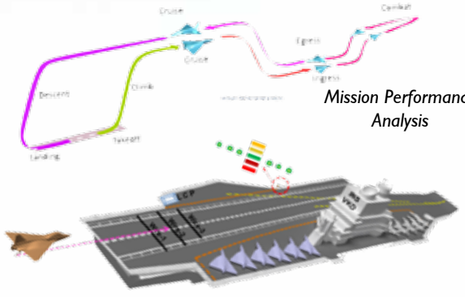
Various conventional and modern tools are used in aerodynamic design and analysis of aircraft configurations at different stages of aircraft development. Wind tunnel testing forms the basis for most of the aerodynamic data generation. Numerical solutions from Computational Fluid Dynamics (CFD) codes of different levels of fidelity, contribute significantly to the aerodynamic database creation apart from providing valuable insights into the air flow behavior in critical regimes of flight. CFD had a major role in design and development of innovative concepts like DSI (Diverterless Supersonic Intake). Engineering methods are also employed on a need basis, for obtaining quick estimates. The aerodynamics data is further refined using flight test based parameter identification techniques.

AMCA Model in Forced Oscillation Rig

LCA AFMk2 Wind Tunnel Model

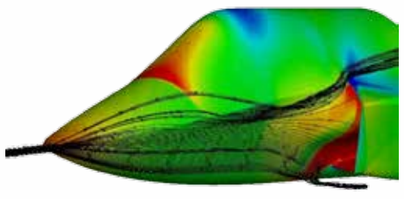
Flight updated aerodynamic and engine data are put to use in computational models to predict aircraft performance during different flight segments. Performance data generated for complete flight envelopes are collated into Operating Data Manual (ODM) for use by the squadrons.

Aerodynamic studies have a major role in ensuring safe store separation. Aerodynamic design efforts are also aimed at achieving superior manoeuvrability, agility and handling qualities.

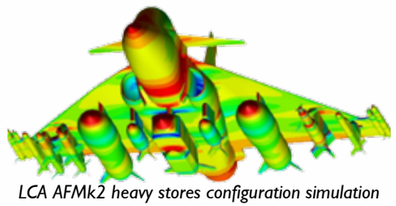


Mission Performance Analysis

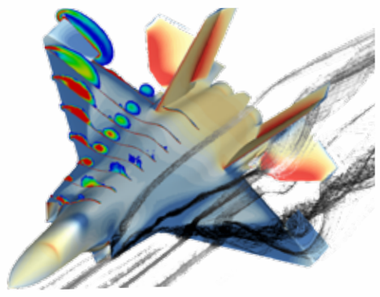
OLS Settings for Arrested Landing on INS-VKD



DSI Design Simulation for AMCA



LCA AFMk2 heavy stores configuration simulation



Control Power Simulations for AMCA

INTEGRATED FLIGHT CONTROL SYSTEM

- State of the Art, Full authority, Quadruplex Digital Fly-By-Wire Flight Control System (DFCS)
- Fault Tolerant Digital Flight Control Computer with built-in Redundancy Management (Fail-Operational, Fail-Operational, Fail-Safe)
- Stand-alone Fail Operational, Fail Safe Air Data System with dedicated Air Data Computers (enhanced with functionality for Auto-throttle and LEVCON Actuators for Navy)
- Robust Control Laws for Stability and Command Augmentation, Carefree Maneuvering, Autopilot Functionality (and Automated Ski Jump for Navy)
- State of the Art Flight Control Actuators with Hydraulic and Electrical Redundancy
- Extensive range of World Class Ground Test Facilities with relevant Check-out Systems for

  - Development of Flight Control System using Advanced System Simulation Facility
  - Evaluation of Handling Qualities on High Fidelity Real Time Simulation Platform
  - Non-Real Time Test Facility for Software Development
  - Hardware-in-loop Simulation
  - Structural Coupling Test
  - Flight Control Actuator Development and Laboratory
  - Lightning Test and Flight Test

Iron Bird

Full Mission Pilot Training Simulator

Lightning Test Facility

Flight Control Actuator Laboratory

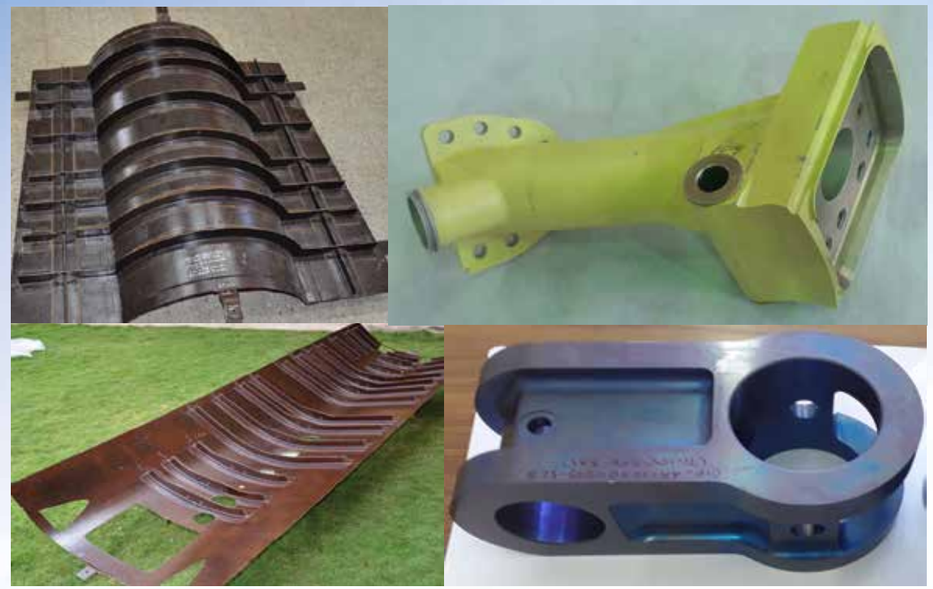
Mini Bird Facility

System Analysis & Evaluation Facility

AIRFRAME

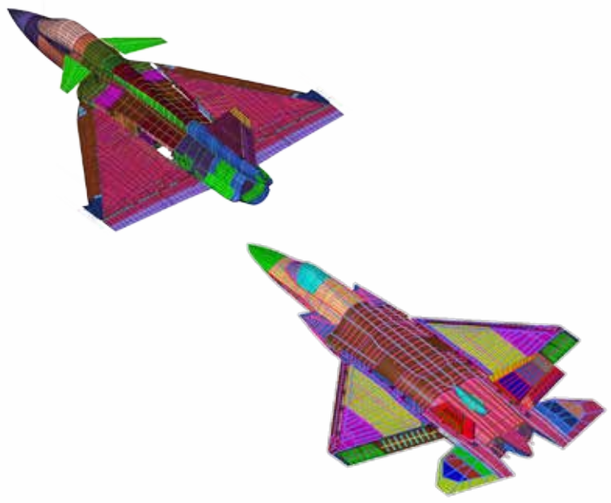
Indigenous Material Technologies and Processes

- Development of advanced processing technologies for carbon fiber composites.
- Indigenously developed metallic materials and processes like large size aluminium alloy and titanium forgings, control stretched extrusions, maraging steel and PH stainless steel



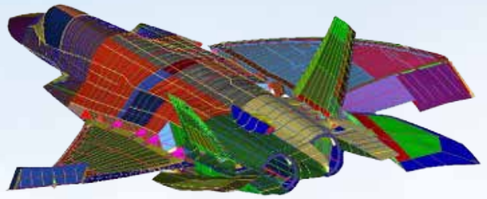
Design and Development

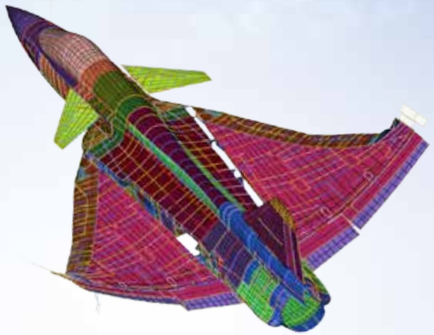
- Structure made of both advanced Metallic and Composite Materials
- Optimized Structural Design considering strength, buckling and aero-servo-elastic requirements using high end CAD tools
- 90% of wetted surface area of the aircraft is made of composites, remaining Aluminium and a few critical components made of steel and titanium

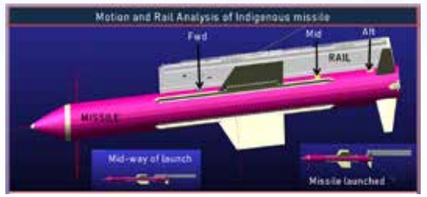


Analysis and Simulations

- Conceptual, preliminary and detailed analysis of airframe structures to arrive at a safe configuration meeting the strength and stiffness requirements.
- Static, Fatigue, Buckling, Natural Frequency, Explicit , Transient , Aeroelastic, Stability and Response analyses
- Advanced simulation of complex operational scenarios like wake encounter, bird strike, fuel slosh, arrestor barrier engagement and belly landing







- Preliminary Design Review (PDR) of LCA AF Mk 2 and AMCA Structures completed.

Testing

Successful completion and matching with predictions for:

- In-flight refueling trials for FAAR Probe
- Supersonic carriage trials of Centre line 725 Ltr Droptanks
- Arrested landing shock tests of inboard BVR Pylon for LCA Navy
- Flight flutter tests for clearing Envelope of new FOC stores
- Shock and Vibration clearance of Airframe and equipment during LCA Navy Carrier Deck Landing
- Envelope clearance of 8g and -3.2g for LCA Tejas Trainer

Work centres: NAL-CSIR, R&DE (PUNE)

PROPULSION SYSTEM

Engine – Aircraft Integration

- Design and development of starting system
- Indigenous design of Mk1 Engine inlet K-Seal
- Avionics Interface Control and Engine Health Monitoring
- Engine mounting and bay ventilation system design
- Quick Engine Removal & Installation using Winch system
- Ergonomic Single Throttle Controls for twin engine AMCA

Performance Analysis and Flight Testing

- Onboard Thrust Estimation & Display for Ski Jump Takeoff
- Thrust droop optimization
- Engine control fine-tuning for high Altitude operations
- Engine and Inlet Compatibility Analysis Operating Envelope definition
- Infrared Signature estimation and reduction through design
- High Fidelity CFD, Critical Frequency Analysis, Thermal and StructuralAnalysis

Engine Maintenance and Testing

- O and I level maintenance-Module replacement
- Engine Management and Parts life tracking system (EMPLTS)
- Universal ground test facility - Defect investigation & Rectification
- Mobile Engine test facility-On Field diagnosis
- Ground Support and Handling Equipment

Indigenous Engine Starting System

- Development of Gas Turbine Starter Unit Mk2
- Starting Capabilities proven up to 20000 Ft, -20 DegC at Khardungla - Leh
- Consecutive start capability within short duration: 30 Sec
- Self-contained lubrication system

Mobile Engine Test Facility (METF)

- Portable to enable quick turnaround operations
- Deployable by air transport at any Air base
- Aircraft Carrier Compatible for Naval Operations

Engine Management and Parts Life Tracking System (EMPLTS)

- Tracking of Life Limited Parts
- Deployed for Squadron Operations for IAF
- Schedule Maintenance and Inventory Planning

GENERAL SYSTEMS

Major Mechanical System includes Microprocessor Controlled Brake Management System, Environment Control System, Fuel System, Nose Wheel Steering System, Landing Gear System, Hydraulic System, Secondary Power System, Life Support System, Escape System.

Major LRUs Developed by ADA are Aircraft Mounted Accessories Gear Box, Filters, Uplocks, QDCs, NRV's, Gimbal joints, Temperature Control Valve, Cabin Shut-off Valve, Ten different types of Compact Plate & Fin Type of very High & Low Temperature Heat Exchangers. All LRUs have been productionised to facilitate Equipping of Series Production.

Aircraft Mounted Accessories Gear Box (AMAGB)

AMAGB is a single input, multi output gear box, which receives its input drive from the engine through Power Take-Off (PTO) shaft at rated speed of 16,810 r.p.m.

AMAGB mounts and drives four aircraft accessories on its output pads viz., two hydraulic pumps, one generator and one starter unit.

Together this assembly caters to a major part of hydraulic and electric power requirements of the aircraft and hence forms a crucial part of the Secondary Power Systems.

LCA - AMAGB with Aircraft Accessories

Fixed Air to Air Refueling (AAR) Capability

Extended combat radius of aircraft.

Increased effectiveness of surveillance, patrol and carry more payload.

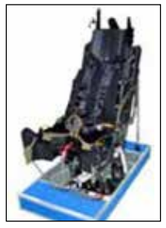
Air Refuelling capability could be utilized as force multiplier.

Developed with the partnership of M/s. Cobham, UK., Structural parts manufactured by M/s. GTTC & M/s. CTTC.

Ejection Seat

The Ejection seat is a light weight, state of art, fully automatic, cartridge operated, rocket assisted, Zero-Zero category seat for Tejas aircraft.The ejection provides fully automated survivable escape for all aircrew members within the percentile accommodation limits and over the escape performance envelope specified.

M/s. Martin Baker, UK is the source partner for Tejas Aircraft.



Canopy Severance System (CSS)

CSS is state of the art escape path clearance system & utilizes optimized Flexible Linear Shaped Charge.

CSS consist of two sub-systems namely Ground Egress System (GES) & In-flight Egress System (IES).

Canopy Severance System is designed & developed by ARDE & HEMRL, DRDO labs.

Compact Heat Exchangers

ADA and BHEL Designed and Developed 10 types of Compact Heat Exchangers for ECS and SPS.

These Compact Heat Exchangers are different types Cross Flow, Counter Flow, Parallel flow and Cross counter flow.

These are made up of Aluminium alloy and Stainless Steel alloy varying heat loads between 2 kW to 266 kW for various fluids of Air-Air, Air-Fuel, Fuel-Hydraulic-IDG/Gear Box oils.

These are airworthy certified and are flying for over 2150 hours successfully.

Mechanical System LRUs

30 types of Hydraulic system, 20 types of Fuel system & 2 Types of ECS LRUs have been indigenously Designed & Developed by General Systems Directorate through DRDO Lab & MSME Establishments.

Productionisation of such LRUs are done through GTTC, CTTC and many Private Industries.

Transfer of Technology done by ADA to HAL Accessories Division, Lucknow for seamless supply to Tejas Programme.

Gimbals & Gimbal Assembly with Venturi

Gimbal Assy. with venturi is designed for Max. Operating Temp: 650 °C with Max. Operating Pressure: 37 bar'g' and Movement of ±10mm (Three axes). M/s Metallic Bellows, Chennai and M/s Veekay Industries, Mumbai are the Production Centers.

Hydraulic System Filters

Hydraulic system is fitted with 9 types of filters in pressure, return and case drain lines.

Filters are rated with $\beta_{10} \geq 100$, $\beta_{15} \geq 100$ & $\beta_{25} \geq 100$ based on the location in the hydraulic system.

Filter production centre is M/s CTTC, Bhubaneswar. Filter element is developed by M/s Mikro Flo Filters, Hyderabad.

Shape Memory Alloy (SMA)

For secured and reliable joint between Aluminium tube and Non-Metallic sleeve.

Developed in Partnership with BARC, Mumbai.

SMA sleeves are airworthy certified and India's first dedicated SMA production plant established at Foundry and Forge Division of HAL, Bangalore.

Carbon-Carbon Composites for Aircraft Brakes

Provide drag

Absorb Kinetic Energy by converting into heat.

Hold Aircraft stationary against Engine thrust.

Carbon-Carbon Brakes are Developed by ASL, Hyderabad and Production center is Graphite India Ltd, Bangalore.

Uplock

To lock the undercarriage (U/C) and its doors on retraction in the up position.

Locking is mechanical and unlocking is controlled hydraulically. M/s Turbo Tech India Pvt Ltd., Bangalore is the Production Center.

OBOGS CENTRIC INTEGRATED LIFE SUPPORT SYSTEM (ILSS)

Introduction

On-Board Oxygen Generation System (OBOGS) that has the capability to generate regulate and provide the breathing gas to the pilot(s) as per their requirements with completely automated functions including Anti-G protection and pressure breathing functions. The complete system is called as Integrated Life Support System (ILSS).

Advantages of ILSS

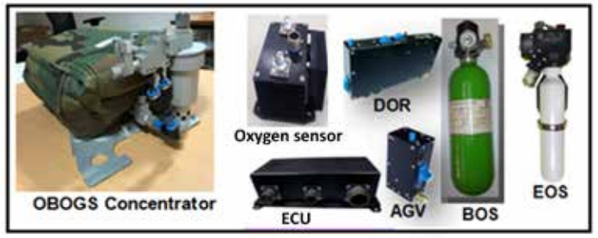
- Mission Flexibility - Increases the flight duration for longer missions with Aerial Re-fuelling
- Completely eliminates the logistics, Oxygen Ground Support Equipment and its maintenance
- Provides Breathing gas free from cockpit contaminants such as smoke and fumes
- Minimises the turn-around period between flights
- ILSS is indigenously designed by DEBEL, DRDO and jointly developed by ADA & DEBEL.

ILSS System for LCA

- Two bed system
- Single system Designed for single and Twin crew
- Common system designed for both Air force and Navy variants.
- Drop-in Replacement for existing LOX system.
- Back up Oxygen for 40 minutes for single crew.
- Emergency Oxygen supply for 7 minutes.

Major Sub-systems

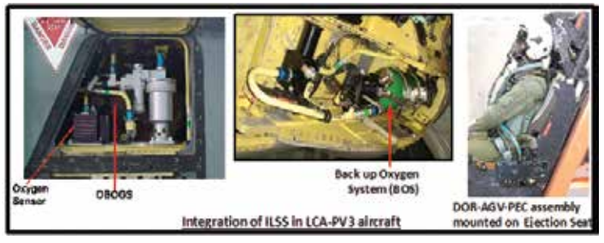
- (a) OBOGS Concentrator: 2-bed system which can produce Oxygen enriched air w.r.t altitude.
- (b) Oxygen Sensor: The Oxygen Sensor is solid state electrolyte type Zirconia based (ZrO_2).
- (c) Demand Oxygen Regulator: Regulates the breathing gas supplies from OBOGS, BOS or Emergency Oxygen System (EOS) and supplies it to the pilot on demand.
- (d) Anti-G valve (AGV): Inflates Anti-G suit (AGS) at a pre-determined suit pressure w.r.t G.



- (e) Back Up Oxygen System (BOS): Supplies 100% Oxygen for 40 minutes as an alternative source in case of failure of OBOGS.
- (f) Emergency Oxygen System (EOS): Supplies 100 % Oxygen for 7 minutes during Ejection.

Integration on aircraft

- Airworthy ILSS is integrated in LCA- PV3 aircraft for flight test evaluation
- Exhaustive Flight Test Instrumentation including Pilot mounted FTI sensors integrated.
- Engine Ground Run (EGRs) checks conducted.
- Flight Test evaluation is planned.



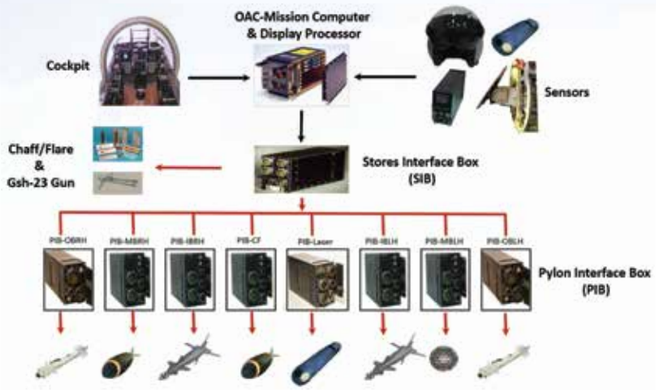
AVIONICS AND WEAPON SYSTEM

Highly fault tolerant Avionics System Architecture supported by dual redundant Open Architecture Mission & Display Management Computer and robust dissimilar backup Avionics system.

Advanced NVG compatible Glass Cockpit with Raster HUD and HMD system along with High Performance Graphics coupled with sophisticated multiplexed controls to Support Situational Awareness, Decision Support, Data Fusion and Net-centric Warfare provision.

Effective Man Machine Interface with Offensive and Defensive systems like Multi-Mode Radar, Litening Pod and Radar Warning Receiver, Identification of Friend-Or-Foe is achieved in a way to reduced Pilot work-load.

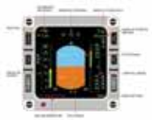
Digital Weapon Management System compatible to indigenously developed weapons as well as compatible to MIL-1760C Russian and Western weapons.



Capable of Air to Air Attack - Close combat missiles and Beyond Visual Range Missile & Air to Ground attack - Conventional and Guided bombs in all-weather Day Night using Advanced Integrated Avionics Suite.

UML Based Modeling, IEEE-12207, ADA-95 certified On-board Avionics Application Software and Single Avionics Suite cater to multi-role operational and maintenance aspects across aircrafts variants.

Computer Controlled Utility System and Management System (USMS) for Quick Turn-around Service through Hot-refueling on Ground and Endurance enhancement through Aerial refueling.






PILOT VEHICLE INTERFACE DESIGN AND EVALUATION

Pilot Vehicle Interface (PVI) of a fighter aircraft determines the capability to carry out mission. High Fidelity Simulators are built for finalizing the requirements starting from conceptualization to testing the system with Pilot and Hardware in Loop environment on ground. This reduces the flight test effort, time and cost considerably.

Avionics Bird

- Capability to evaluate Flight test points
- Pilot, Hardware in Loop testing
- Weapon algorithm Evaluation
- Ipad based Interface for simulation control
- Full mission training, Dog Fight, Formation flights among simulator variants
- Reconstruction of actual flight sorties for Mission analysis
- Terrain Database providing sensor and visual imagery for combat simulation
- Reduces flight test effort, time & cost

360° Tejas Virtual Flight Simulator

- Capturing of Cockpit PVI Requirements & Finalization
- Finalization of cockpit controls using virtual Switches, Indicators and Displays
- Reconfigurable cockpit based on Tejas variants
- Training for complex scenarios: Mid-Air Refueling
- Seamless OWI simulation for Immersive Virtual Reality Environment

System design & Evaluation Facility

- Capable of Mission Scenario Analysis
- Avionics System Interface design
- Evolution and finalization of In flight Emergency Procedures
- Cockpit control conflict management studies for 2-seater aircrafts

Cockpit Environment facility

- Cockpit assessment and ergonomic studies
- Control and Display Pilot Vehicle Interface evaluation
- Ground Operating Procedures Evaluation
- Day & Night Environment Evaluation

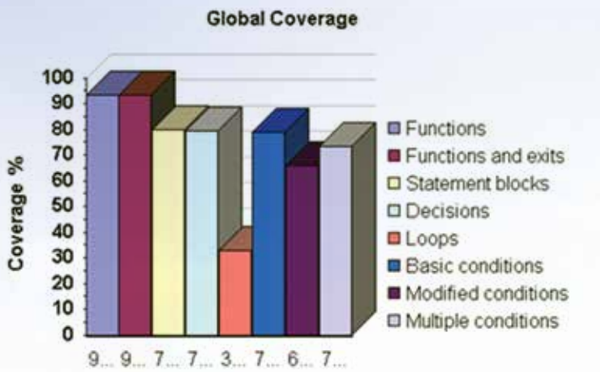
INDEPENDENT VERIFICATION & VALIDATION (IV&V)

The IV&V laboratory at ADA has been set up to address the safety issues of software intensive systems of LCA, thereby obtaining a high level of confidence in the operations of new systems prior to their use.

IV&V plays a major role in the design and development of embedded software and aims at development of hazard free and mission-success oriented software employing modern CASE tools viz. Modeling and simulation, Rapid prototyping, Tool based analysis and Randomised **N**on **R**eal **T**ime testing (**NRT**).

Seven safety critical and **twenty three** mission critical software systems of TEJAS have been evaluated and over 3000 successful sorties of TEJAS have been completed adhering to IV&V practices.

IV&V has evolved guidelines for Development life cycle of **FPGA** based Designs. IV&V follows standards like **IEEE-12207** and **RTCA DO-178B** for software development. The IV&V process has evolved to support concurrent software development techniques using **OOAD** and Model Driven Development (**MDD**) methods for LCA applications.

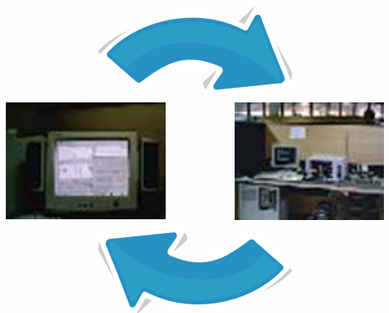


Coverage Analysis

KIVIAT Graph

Tools Used

- Matlab/Simulink
- Rhapsody
- Rational Development Suite
- AdaTest95
- Questa Prime
- LDRA
- Understand for Ada/C++
- Beyond Compare
- Cameo Systems Modeler



Non Real Time Test Setup

NRT setup at IV&V lab has been developed in-house by using COTS s/w to do V&V and stress test of Safety Critical On Board s/w in Non Real Time mode on a target board.

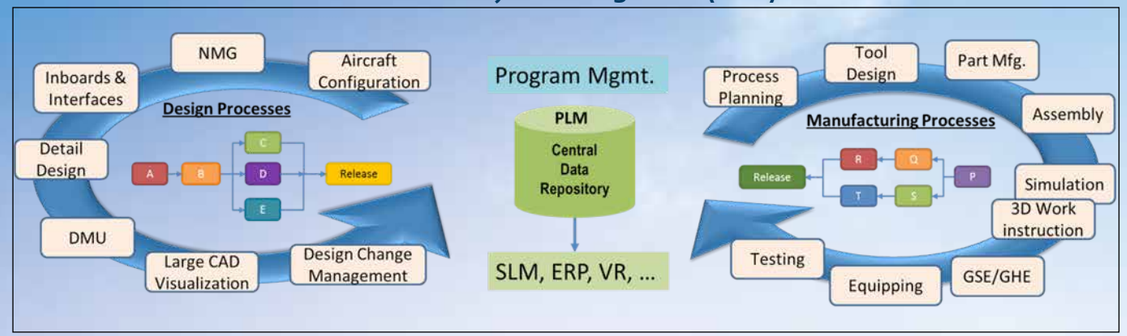
QUALITY ASSURANCE AND SYSTEM EFFECTIVENESS GROUP

Quality Assurance and System Effectiveness plays a vital role in product assurance ensuring Airworthiness and Safety of LCA.

Reliability & Maintainability	System Safety	Survivability & Vulnerability	Quality Engineering & Airworthiness
Reliability ➢ Allocations & Prediction ➢ Modeling ➢ Reliability Estimation ➢ Failure Free Operating Periods (FFOP) ➢ Maintenance Free Operating Period (MFOP) **Maintainability** ➢ Built-in test ➢ Accessibility studies ➢ Mean Time to Repair (MTTR) allocation and Estimation ➢ Estimation of OTRS &MMH/FH ➢ Spare parts Management LRU/Components Lifing	**Safety Analysis** ➢ Functional Hazard Analysis ➢ Fault Tree Analysis (FTA) ➢ Zonal Safety Analysis ➢ Common Mode Analysis ➢ Particular Risk Analysis ➢ Failure Modes Effect and Criticality Analysis (FMECA) ➢ Failure Modes Effects Testing (FMET) ➢ Risk Assessment	➢ Study on enhancement of survivability features ➢ Vulnerability analysis against bullet & bird hits ➢ Protection against EMI/C & Lightning ➢ Rain Protection Requirements ➢ Stealth	➢ Quality control during development ➢ Failure Reporting And Corrective Action System ➢ Qualification for LRU ➢ Formulation of standards and procedures design and development ➢ Configuration Management ➢ Unique Environmental Map for every platform ➢ Rationalization of standards across the programs ➢ Airworthiness & Certification with 'Centre for Military Airworthiness and Certification (CEMILAC) and the Director General of Aircraft Quality Assurance (DGAQA

PRODUCT SUPPORT AND PRODUCTIONISATION

Product Lifecycle Management (PLM)

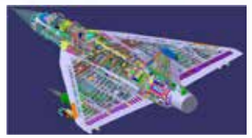


- Comprehensive end-to-end PLM as Single Digital Thread connecting all Stakeholders including Partners
- Adoption of Model Based Definition (MBD) towards paperless Design in 3D
- Effective BOM Management to facilitate Design & Manufacturing of Equipped Modules
- Digital Manufacturing solutions for Methods Planning to Product Assembly and Equipping
- PLM based Program Management for supervision of complete Design and Development process
- Complete traceability across Lifecycle Stages and Change Management with history tracing
- Reporting, Analytics & Dashboard for Progress Monitoring and Decision Support
- Connectivity with Enterprise Resource Planning (ERP), Service Lifecycle Management (SLM) and Virtual Reality (VR)

Productionisation

Aircraft level Digital Mock-Up (DMU)

- Replaces physical Mock-up
- Authenticated data for Manufacturing, Testing, Assembly, Tooling and Inspection



Design and Manufacturing of Wind Tunnel Models

- E1:10 Scale Low Speed Wind Tunnel Model-Mk2
- 1:20 Scale High Speed Wind Tunnel Model- Mk2

1:10 LSWT Mk2 model

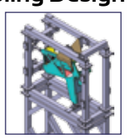
1:20 HSWT Mk2 model

Service Lifecycle Management (SLM)

- ACollaborative Framework between System and Service Engineering
- Change & Configuration Management of ESOP data
- Tail number wise Serialization & Life parameters tracking of Aircraft Equipment
- Aircraft Asset Management, As-Built & As-Maintained structure
- Aircraft activity and snag management ,Work-done report

Aircraft Tooling Design

F1 Fuel Tank Assembly Jig



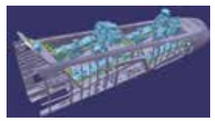
Central Console Assembly Jig

Jig-less Assembly Concepts

Mid Board Slat Assembly

Modularization concept in 3D Harness Design

- Routed as single instead of multiple looms
- Optimal routing, single form board and ease of fabrication
- Reduction of equipping cycle time

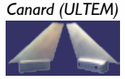


Additive Manufacturing Technologies

- Direct Metal Laser Sintering (DMLS) process for aircraft parts
- Composite Additive Manufacturing and Fused Deposition Modeling (FDM) process for Low Speed Wind Tunnel Models
- Selective Laser Melting (SLM) for High Speed Wind Tunnel Models

Slat Track (Maraging Steel)

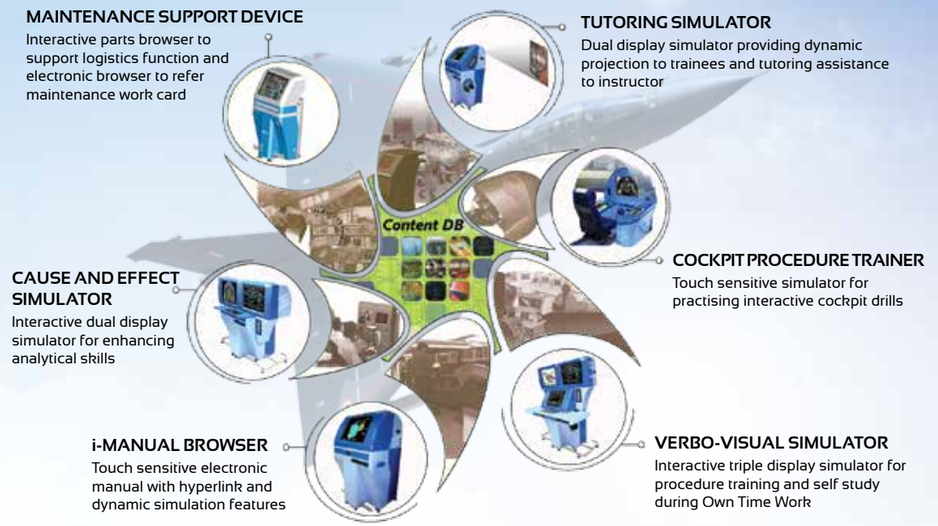
Canard (ULTEM)



Canard (Maraging Steel)

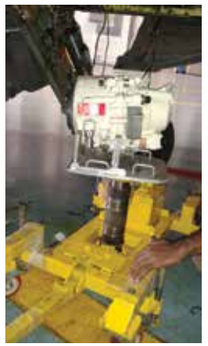
PRODUCT SUPPORT AND PRODUCTIONISATION

Product Support



Maintenance Training Devices

MLG Removal / Installation Trolley



IDG Removal / Installation Trolley

DFCC Removal / Installation Trolley

Universal Weapon Removal / Installation Trolley

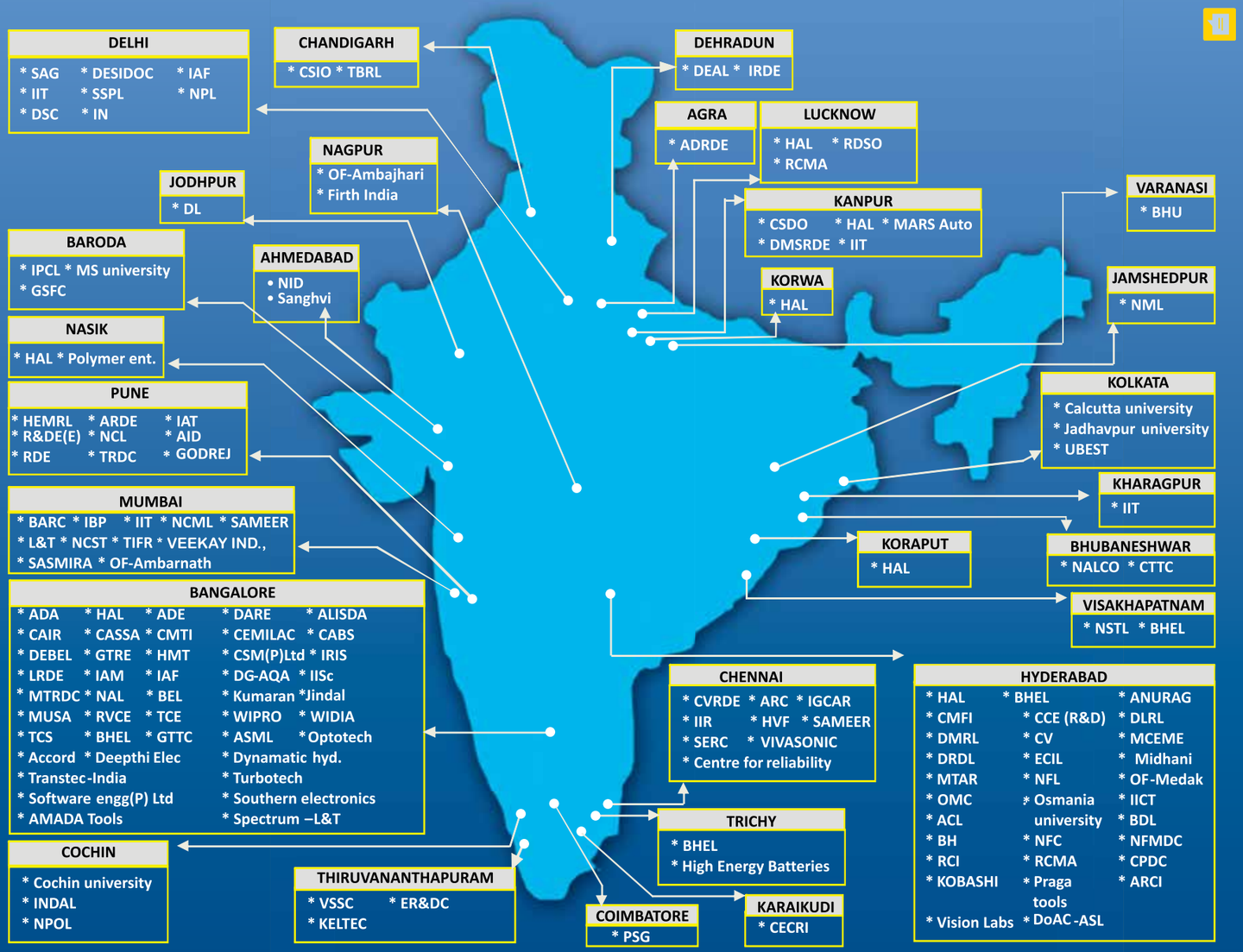
- Multi utility from single trolley
- Shorter aircraft preparation time
- State of the art specialized GSE/GHE
- Indigenously developed with PSUs / Private Industries

Ground Handling Equipment for LCA

FLIGHT TESTING

National Flight Test Centre (NFTC) was formed in 1994 with a mandate to flight test LCA. NFTC is headed by an Air Rank Test Pilot from IAF and comprises of flight test crew from Air Force, Navy and ADA. The flight test effort is ably supported by instrumentation engineers of ADA. Starting with first flight of LCA on 04 Jan 2001, NFTC has flown more than 4956 test flights on 14 Air Force and 02 Naval prototype/ limited series production aircraft leading to Air Force variant achieving Initial Operational Clearance in 2013. LCA was inducted in IAF in 2016. Naval variant demonstrated ski-jump capability in 2014 and full carrier suitable capability tests are under progress. Night trials were successfully undertaken in 2018 for demonstrating the integration of Beyond Visual Range (BVR) Air to Air missiles. The aircraft has successfully demonstrated Air to Air Refueling (AAR) capability which acts as an excellent force multiplier and has enhanced the combat range of the aircraft. This has culminated in achieving FOC in Dec 2018.

WORK CENTRES OF LCA PROGRAMME



"TRAPPED TO PROPEL DREAMS"

Aeronautical Development Agency
(Ministry of Defence, Govt. of India)

Post Box No. 1718, Vimanapura Post
Bengaluru-560 017, INDIA
Tel: +91-80-25233060 Fax: +91-80-25238493

www.ada.gov.in

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