



T-7A: An ASIP Overview



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Today's Presentation

- Purpose: How is the USAF's new trainer progressing with the 5 pillars of ASIP?

TASK I	TASK II	TASK III	TASK IV	TASK V
DESIGN INFORMATION	DESIGN ANALYSES & DEVELOPMENT TESTING	FULL-SCALE TESTING	CERTIFICATION & FORCE MANAGEMENT DEVELOPMENT	FORCE MANAGEMENT EXECUTION

- Overview of the Aircraft
- The T-7A ASIP
- Full Scale Fatigue Test



T-7A Red Hawk Overview

- All-new, purpose-built advanced pilot training system for the US Air Force
- Red tails pay tribute to the legacy of the Tuskegee Airmen



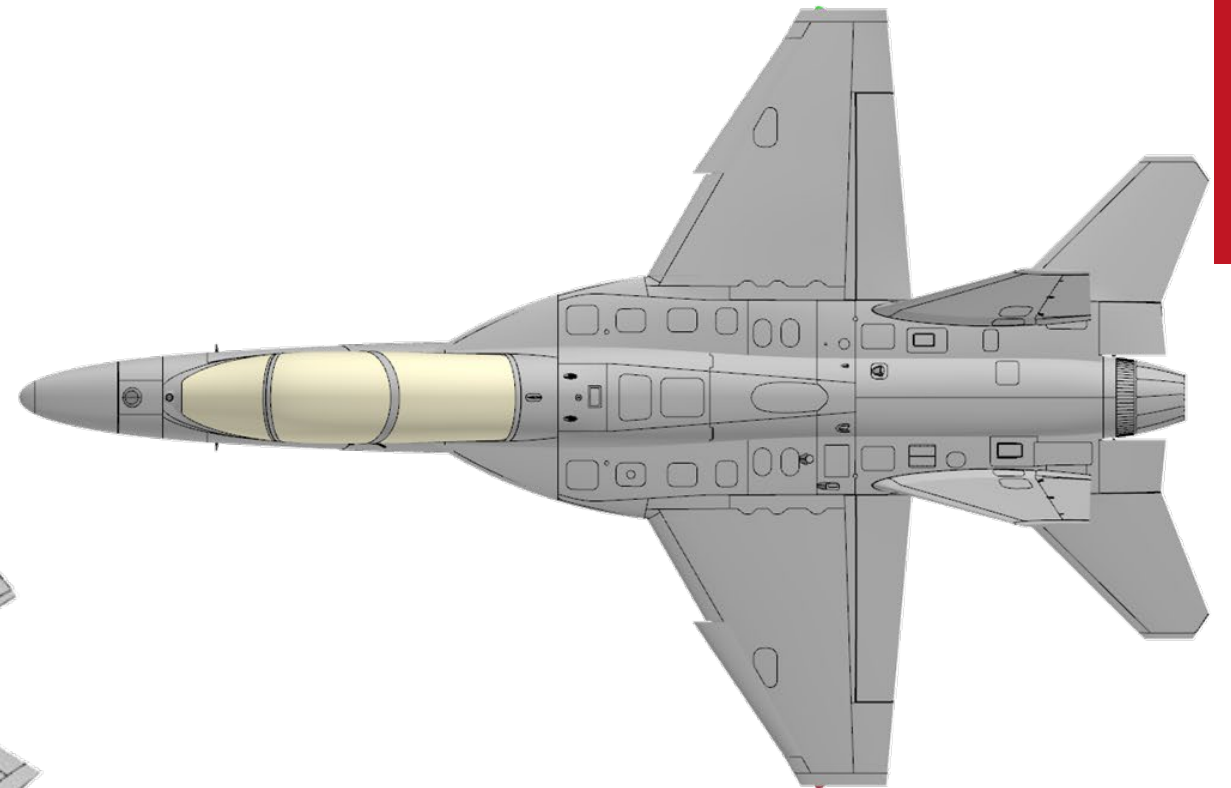
T-7A Red Hawk Overview

- The T-7A aircraft is a high-wing, two-seat tactical training aircraft powered by a single General Electric (GE) F404-GE-103 afterburning turbofan engine
- Modular design driven by digital engineering
- Advanced manufacturing processes to increase efficiency in design and assembly
- Compared to traditional aircraft development programs, T-7A experienced:
 - A 75% increase improvement in first-time engineering quality
 - An 80% reduction in assembly hours
 - A 50% reduction in software development and verification time



T-7A Red Hawk Overview

- We're a small bird...but mighty!



A Max TO Gross Weight T-7A weighs less than the fuel in an F-15



T-7A Red Hawk Milestones

- Concept to first flight in three years: '13 - '16
- Contract Award: Sept '18
- Engineering Manufacturing and Development (Task I and II): '18 - Ongoing
- First production A/C rollout: Spring '22
- Full Scale Static Test Completion: Spring '23
- Military Flight Release: Spring '23
- First flight w/ USAF pilot: Summer '23
- Full Scale Fatigue Test Start: '24



A-2 at the T-7A rollout ceremony Spring '22

The Pillars of ASIP: T-7A Status

Established	Executing	Planning
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Task I	Task II	Task III	Task IV	Task V
Design Information	Design Analyses & Development Testing	Full-Scale Testing	Certification & Force Mgmt Development	Force Mgmt Execution
ASIP Master Plan	Material & Structural Allowables	Static Tests	Structural Certification	L/ESS Execution
Design Service Life & Design Usage	Loads Analysis	First Flight Verification Ground Tests	Strength Summary & Operating Restrictions	IAT Execution
Structural Design Criteria	Design Loads/Environment Spectra	Flight Tests	Force Structural Maintenance Plan	Analytical Condition Inspection
DADT Control	Structural Analysis (Stress, DADT, Sonic Fatigue, Vibe, Aero, Survivability)	Durability Tests	Loads/Environment Spectra Survey System Development	Repairs
Corrosion Prevention & Control	Corrosion Assessment	Damage Tolerance Tests	Individual Aircraft Tracking System Development	Force Mgmt Database Execution
Nondestructive Inspection	Mass Properties Analysis	Climatic Tests	Force Mgmt Database Development	Updates: DADTA, L/ESS & IAT, NDI, CPC & Corrosion, FSMP, Tech Orders, Structural Risk & Certification, Economic Service Life
Selection of Materials, Processes, Joining Methods, & Structural Concepts	Design Development Tests	Interpretation & Evaluation of Test Findings	Technical Orders	
	Structural Risk Analysis	Resolution of Test Findings		
	Economic Service Life Analysis			

Task I: Design Information

- The T-7A ASIP was designed to meet all the reqs of AFI 63-140 / MIL-STD-1530C as they apply to a newly developed aircraft
- Some adjustments to adhere to 1530D:
 - Part criticality classification
 - Resolution of Test Findings
 - Force management database development and technical orders
 - ACI program
- ASIP Master Plan established
- DADT Control Plan established to incorporate DADT into the design, fabrication, assembly and support of the T-7A air vehicle
 - Part classification and control definitions
 - DADT Control Board oversees implementation of the Control Plan

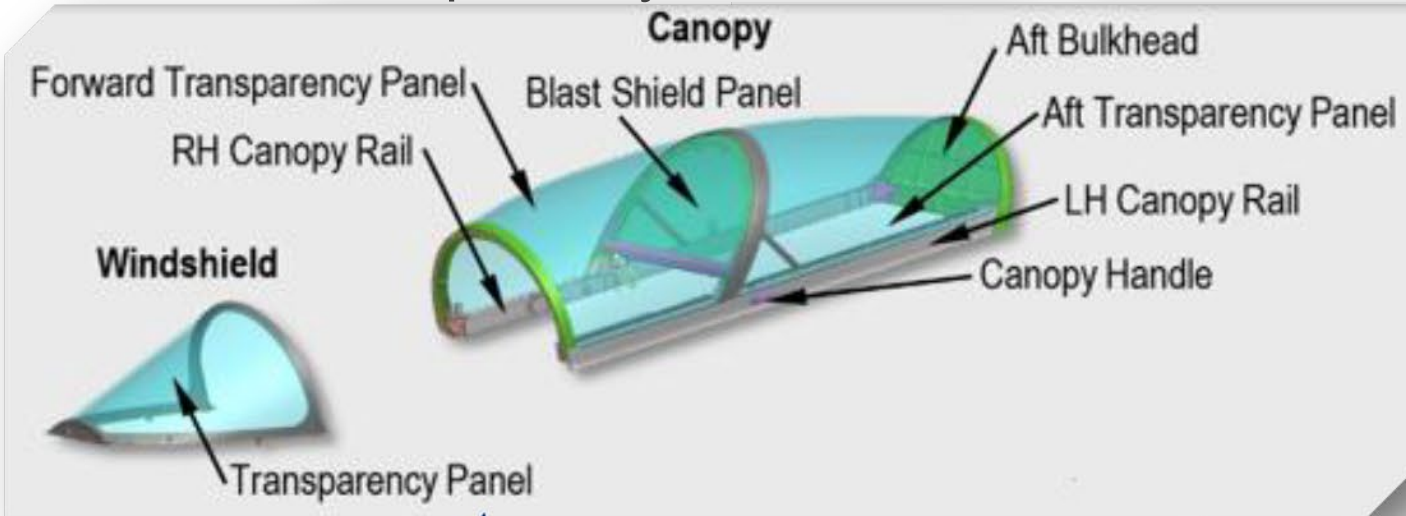
Task I: Design Information

- DADT Design requirements
 - Durability life requirement of 16,000 hours from 0.010” initial flaw for 90th percentile usage spectrum
 - Damage tolerance life requirement of 16,000 hours from 0.050” initial flaw for average usage spectrum

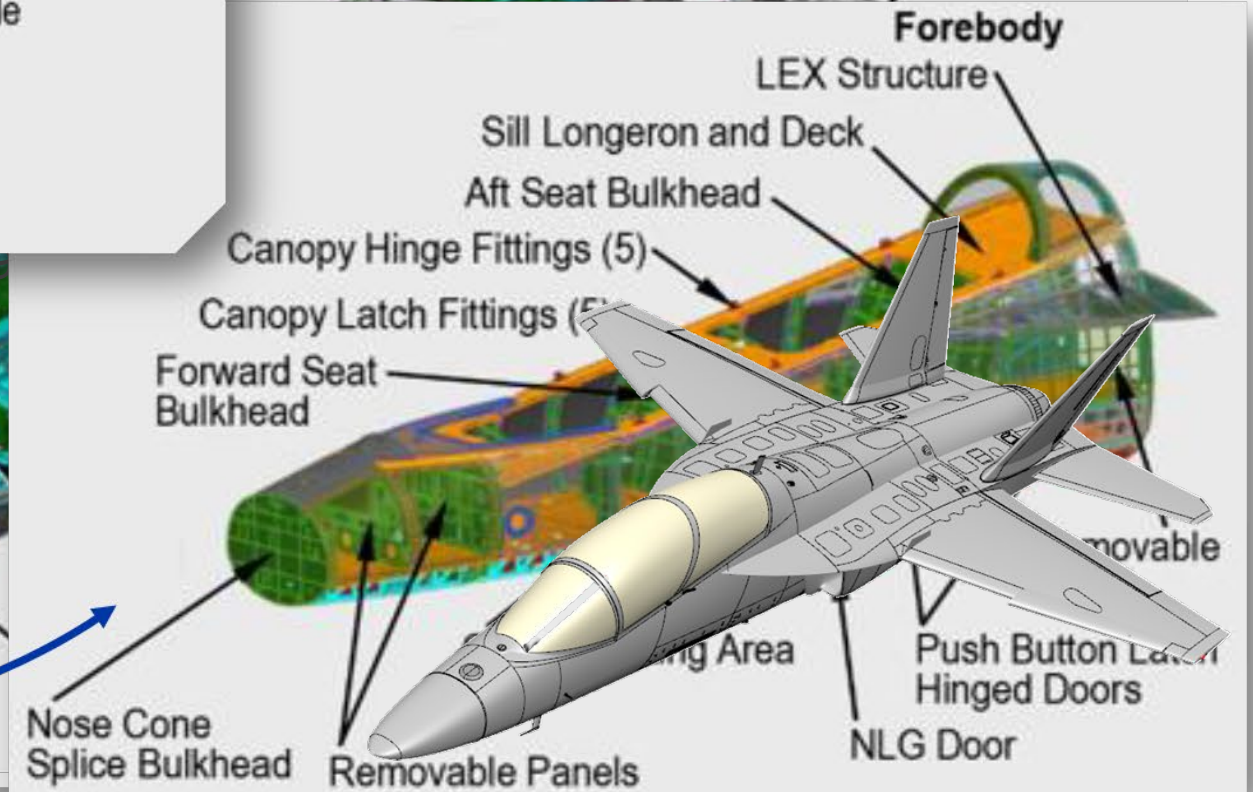
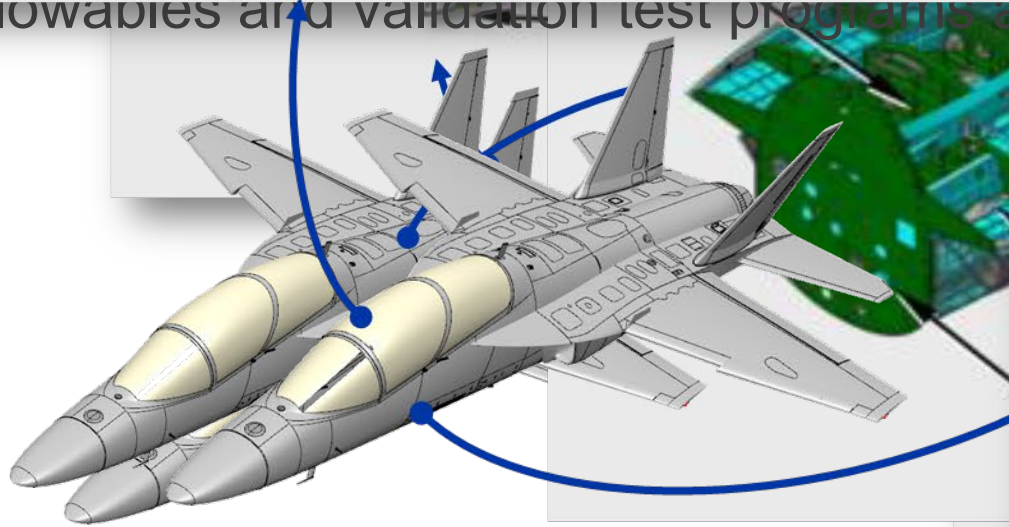
Classification	Requirement	Initial Flaw	Spectrum	Required Analytical Life
FCT / FC	Crack Growth	0.05	50th Percentile	16000
	Crack Growth	0.01	90th Percentile	16000
Durability Critical	Crack Growth	0.01	90th Percentile	16000
Normal Controls	Same as Durability Critical			

Task I: Design Information

- The T-7A is primarily aluminum

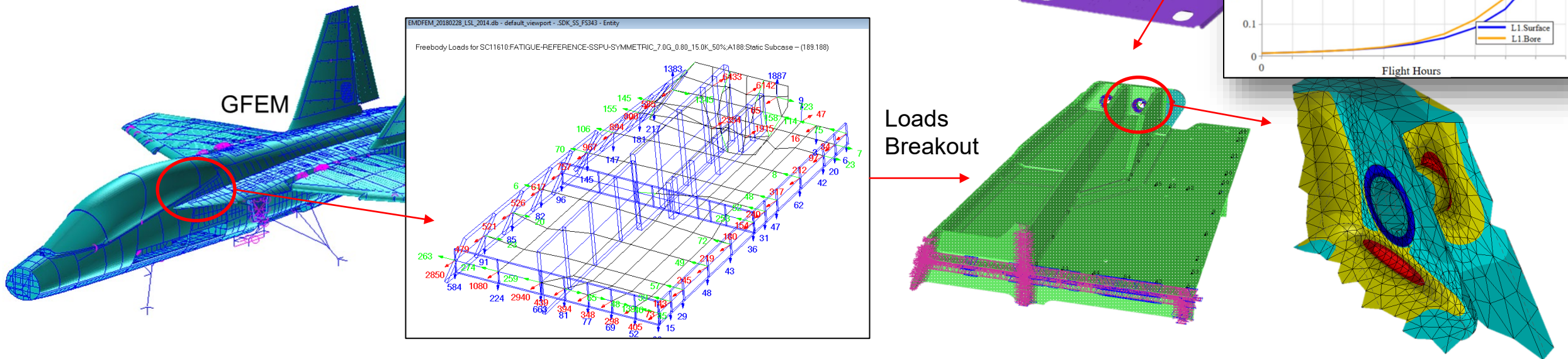


- Allowables and validation test programs



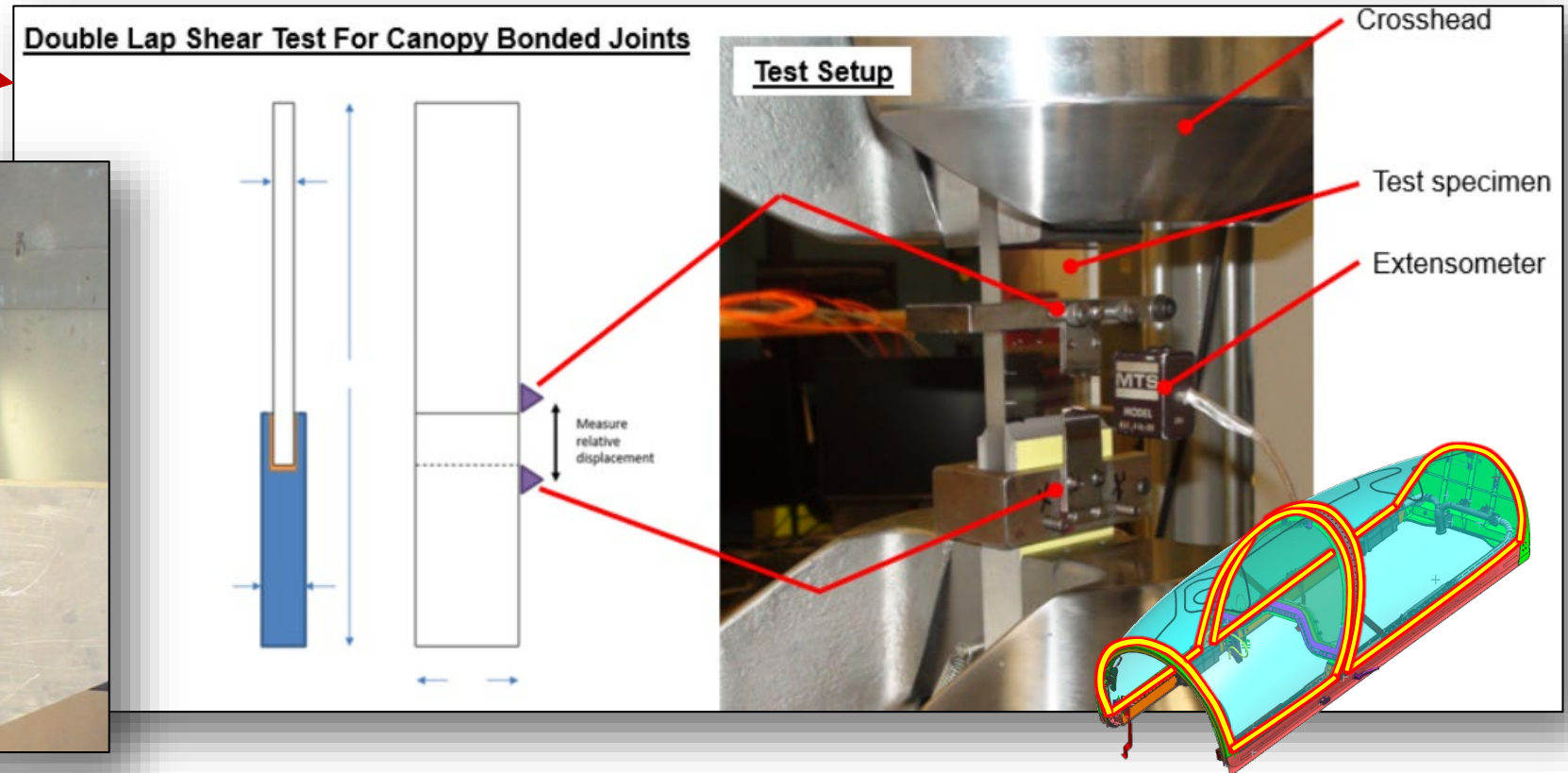
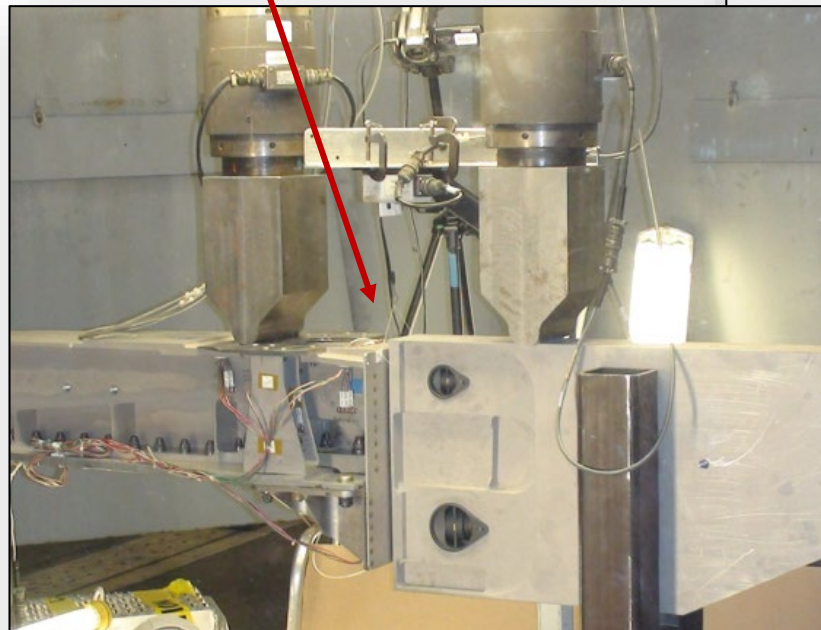
Task II: Design Analysis and Development Test

- Task II is largely established for T-7A
 - Structural analysis performed with respect to loads, stress, DADT, Sonic Fatigue, Vibe, etc.
- For DADT, objective was for all structure to meet required analytical life to remove need for inspections during design service life
 - For all structural components, crack growth analysis and crack initiation assessment performed – CI not a governing criteria
- Typical damage tolerance analysis flow:



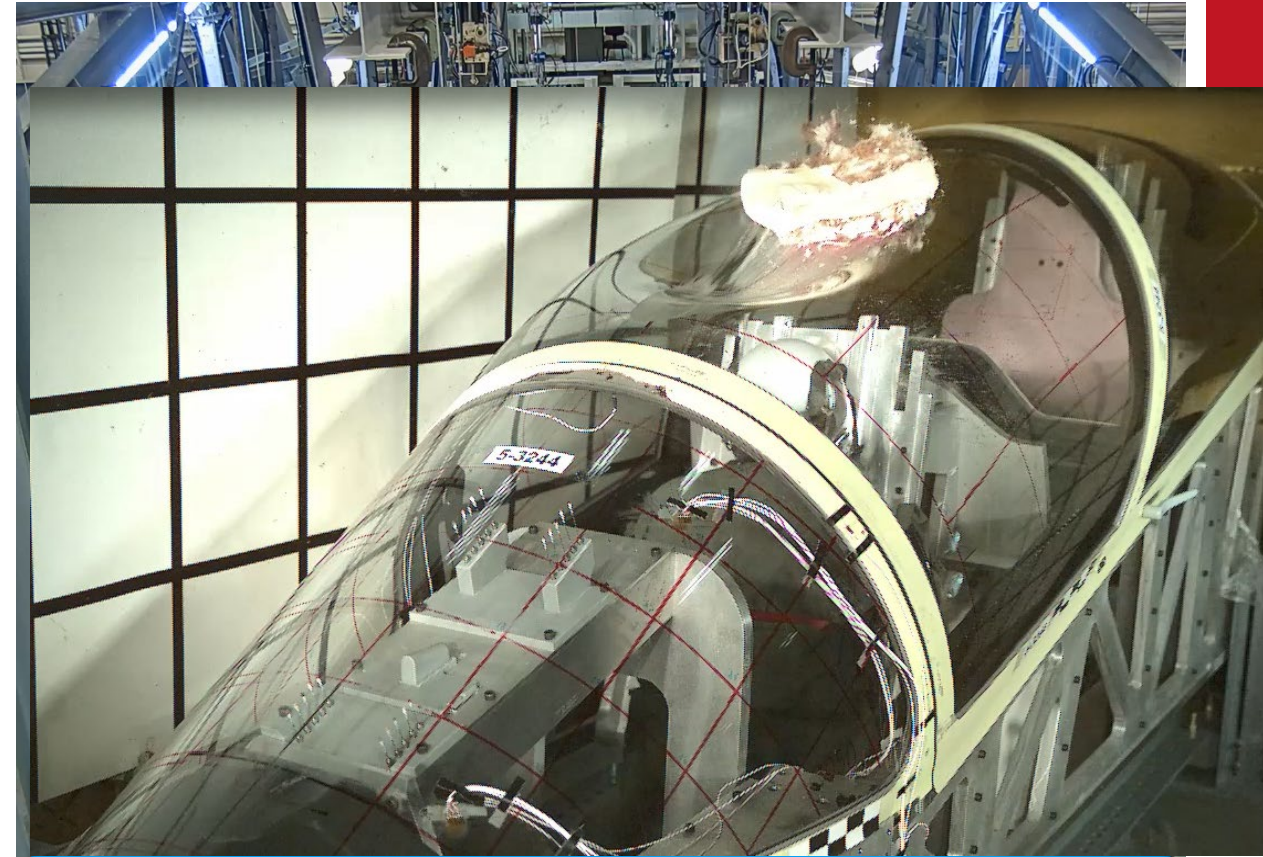
Task II: Design Analysis and Development Test

- Master Event Spectrum (MES) is developed incorporating actual and simulated time histories of the various maneuvers in the T-7A mission mix
 - MES incorporates Buffet and Ground Handling Events in addition to the Maneuver Events
- Development testing ex's:
 - Canopy Bondline
 - Wing attach joint



Task III: Full Scale Testing

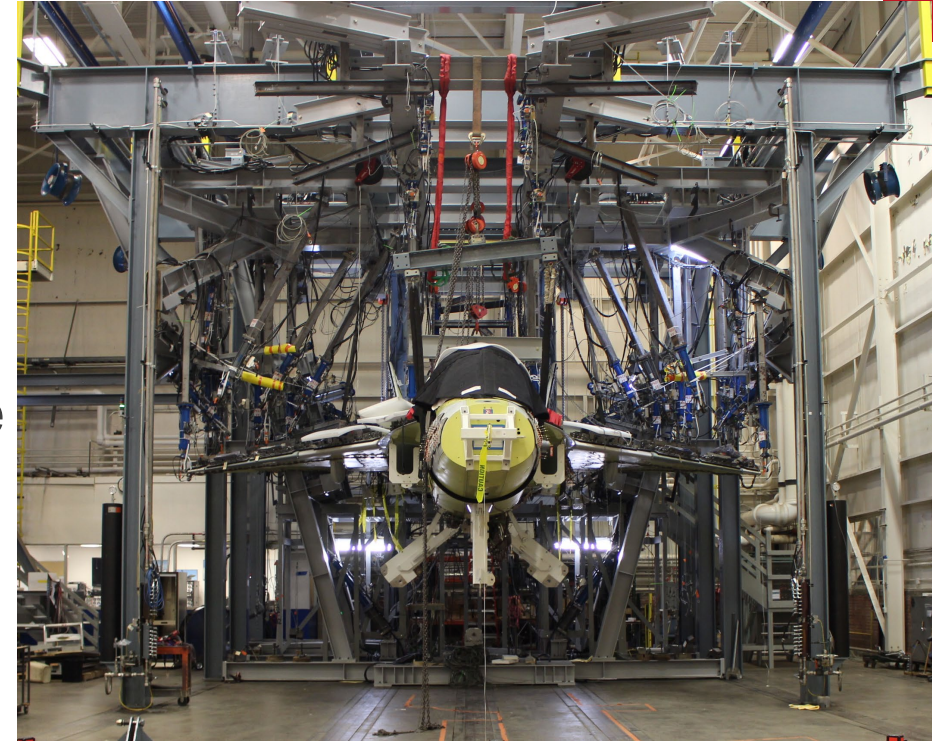
- Task III in full swing, several tests recently completed or in work:
- Static Test – Completed early '23
 - Demonstrated Airframe Capability to 150% Limit Load
 - Successful FEM Correlation with No Internal Loads FEM Updates
- Loads Calibration Test – Completed late '22
 - Developed validated load equations
- Canopy Proof Pressure Testing
- Bird-Strike Testing



**Structural Integrity & Validated
Internal Loads Model**

Task III: Full Scale Testing – Fatigue Test

- Objective: To generate data to satisfy the DADT reqs. of MIL-STD-1530C
 - First and Second Lifetimes -> Durability Test Req
 - Third Lifetime -> Damage Tolerance Req
 - If major structural failure occurs during 3rd Lifetime, but test has not reached the end of the lifetime, test will be considered complete
- Post-Test Teardown will be conducted to correlate analysis to test findings
 - Correlated analysis shows failure would not occur during 2nd LT – Location meets certification criteria
- Correlation required for certification
- Test start scheduled for early '24

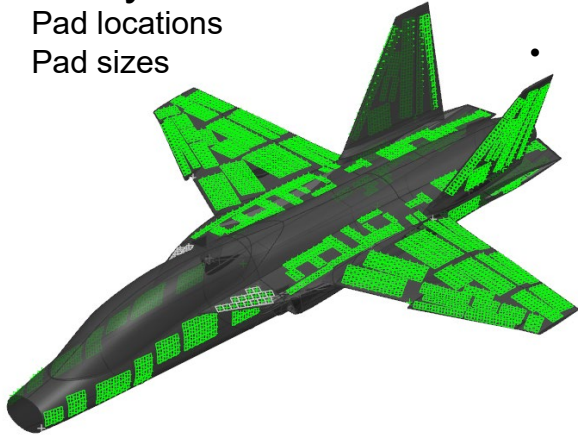


Fatigue Test Article in Fixture

Fatigue Test: Major Systems

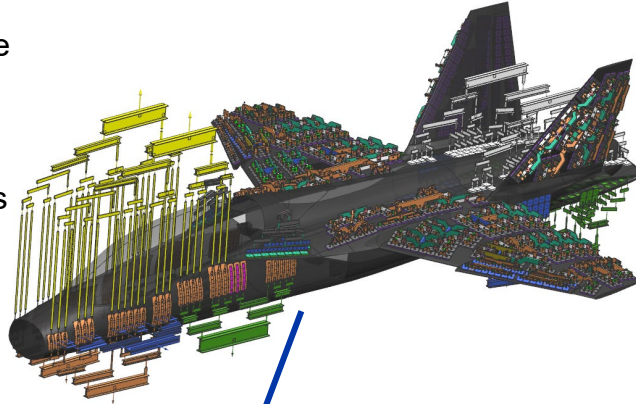
Pad Layouts

- Pad locations
- Pad sizes



Whiffletrees

- Beams to distribute load to pads
- Tension only & Tension + compression styles

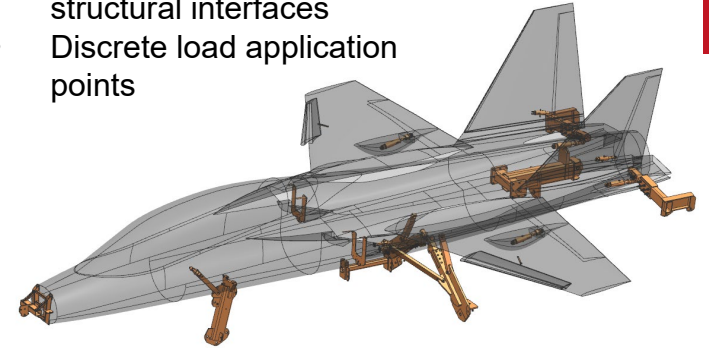


Not Pictured

- Pressurization System (cockpit)
- Load Control/Data Acquisition Systems
- Hydraulic System

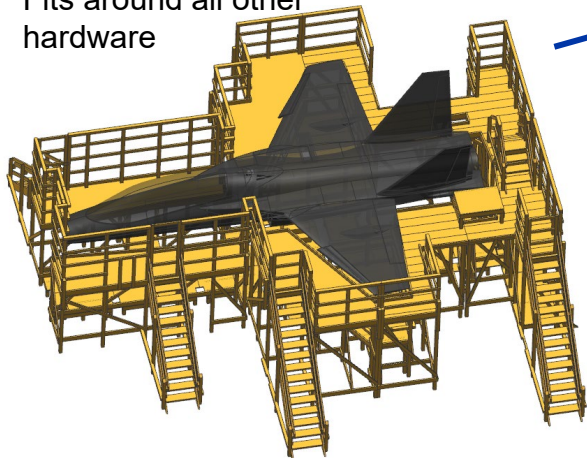
Simulated Hardware

- Attaches to major structural interfaces
- Discrete load application points



Access Platforms

- Fits around all other hardware



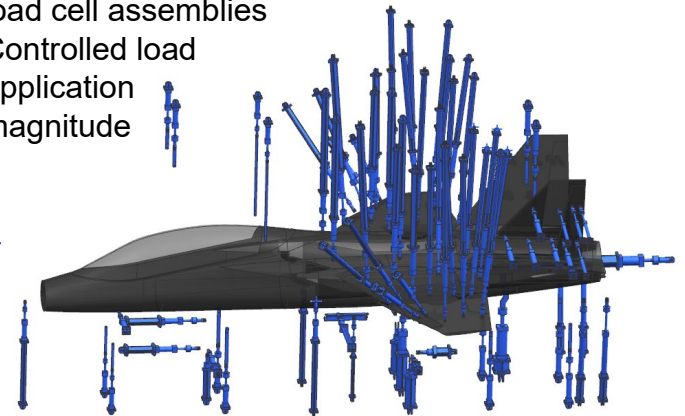
Fixture

- Reacts load system loads
- Positions load systems



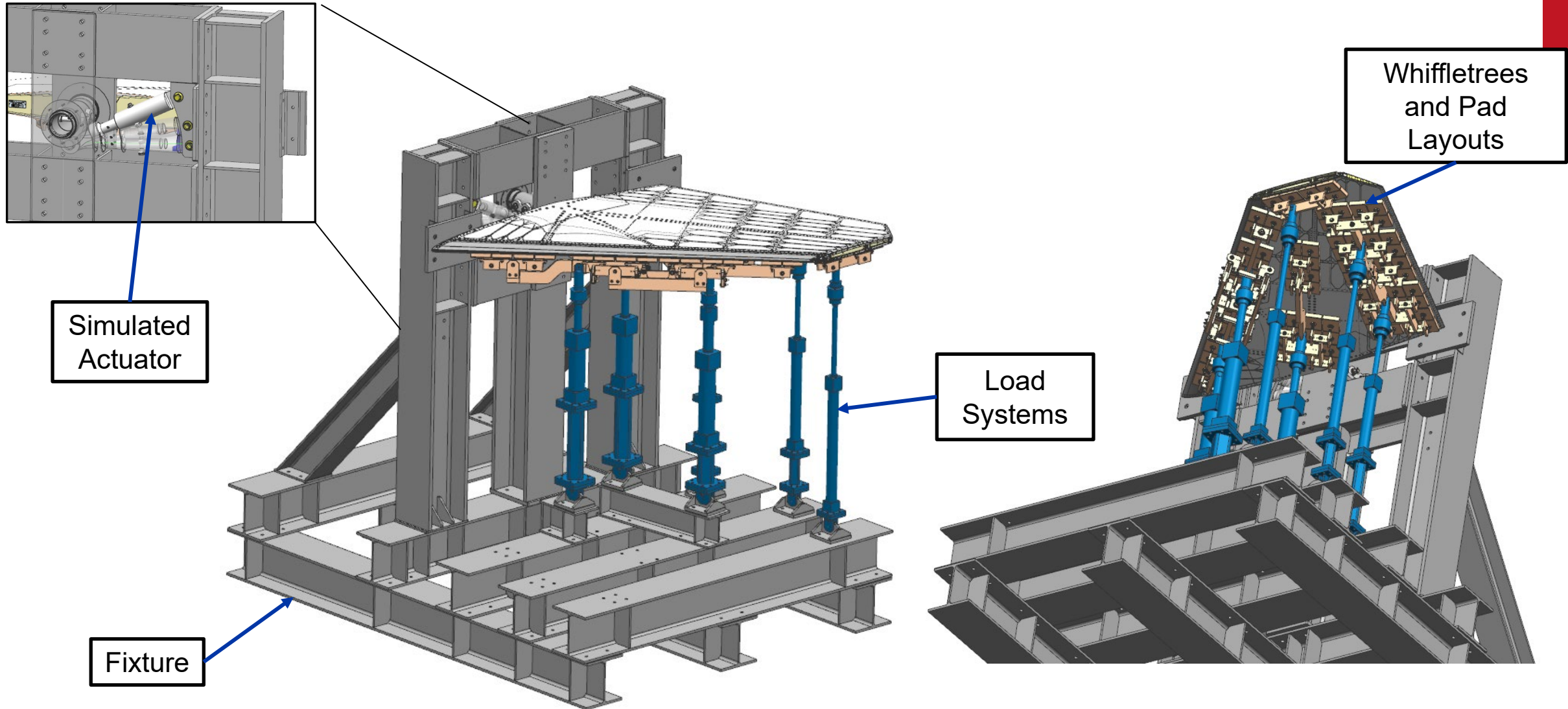
Load Systems

- Hydraulic cylinder + load cell assemblies
- Controlled load application magnitude



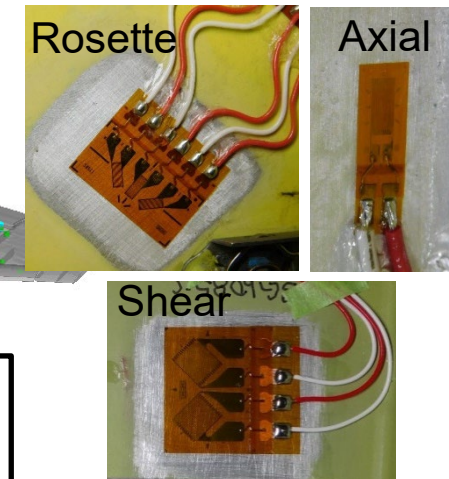
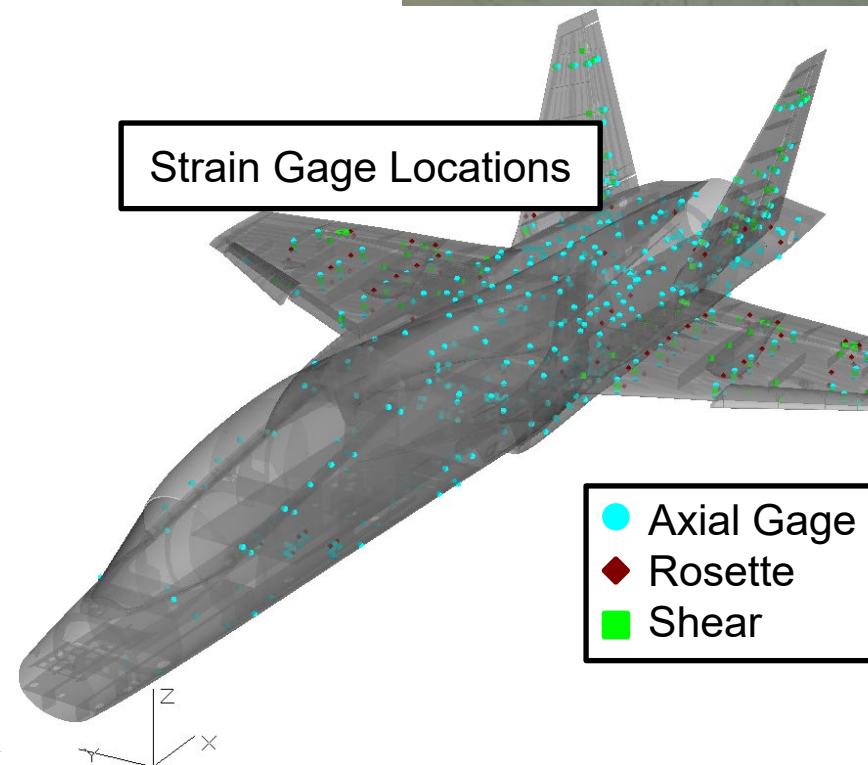
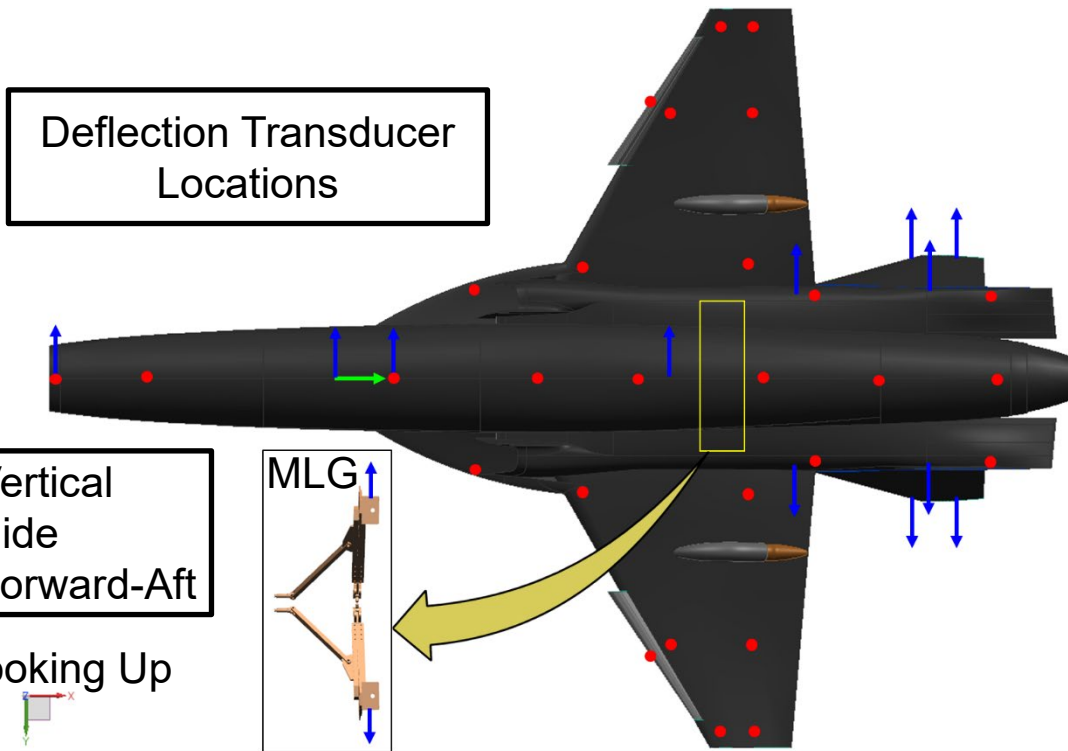
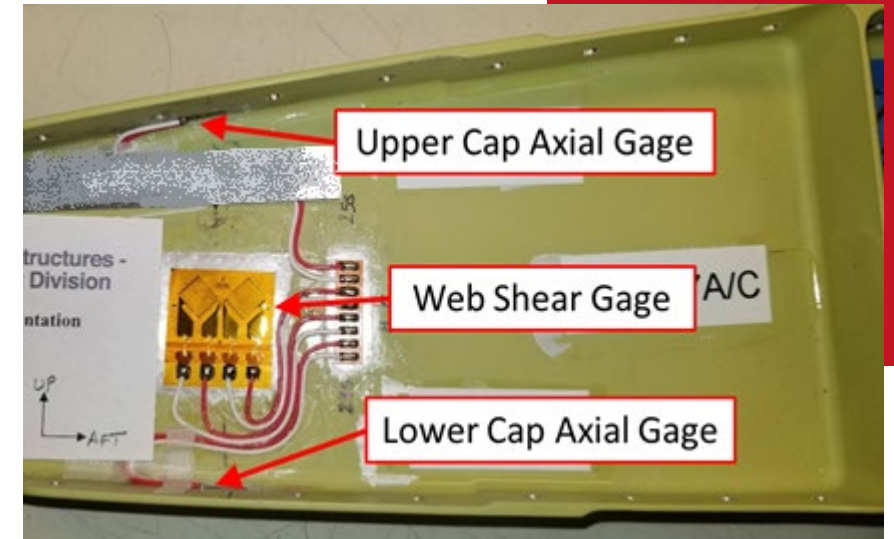
Common Fixture with Static and Loads Cal

Task III: Full Scale Testing - Horizontal Stabilator Test Setup



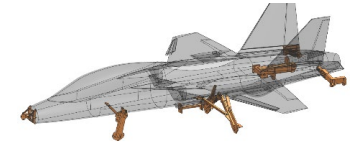
Fatigue Test: Instrumentation Layout

- Strain Gages in Major Load Paths (identical to STA)
- FTA gauges added for detailed model information
- 966 Total Gages (compared to 890 for STA)
- 44 Deflection Transducers



Fatigue Test: Hardware

- Simulated Hardware
 - Nosecone, Air Inlet Lip, MLG, Engine, H-Stabs, Rudder Actuators, H-Stab Actuators, Flaperon Actuators, Slat Actuators
- 1550 pads on full-scale article



Flap Actuator



H-Stab



80 PSI Proof Testing



Engine

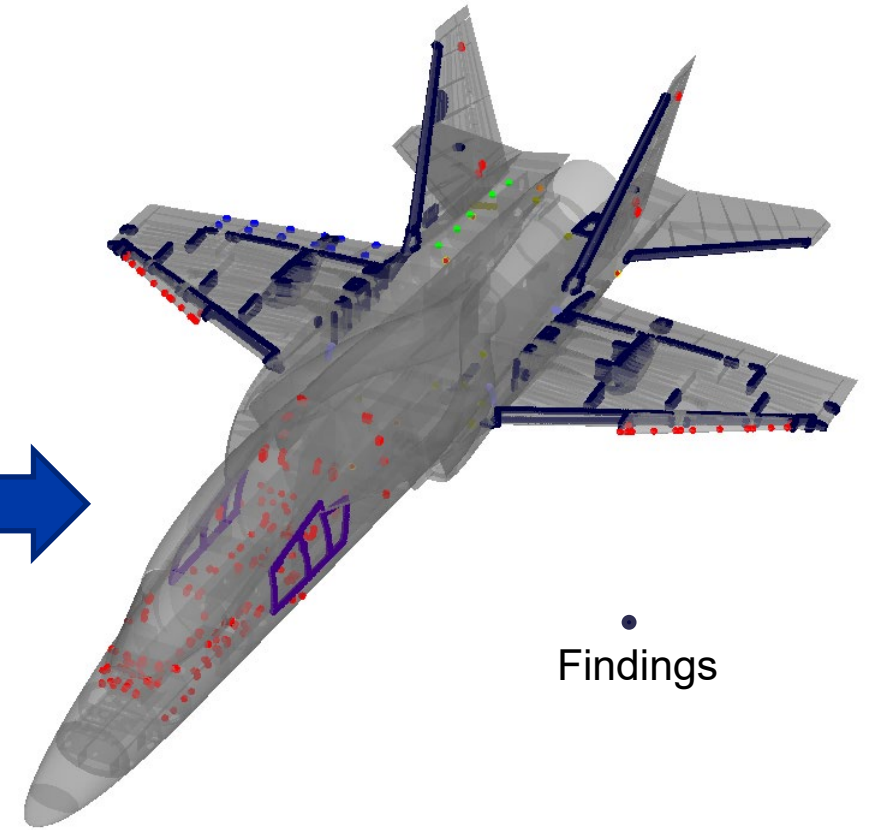
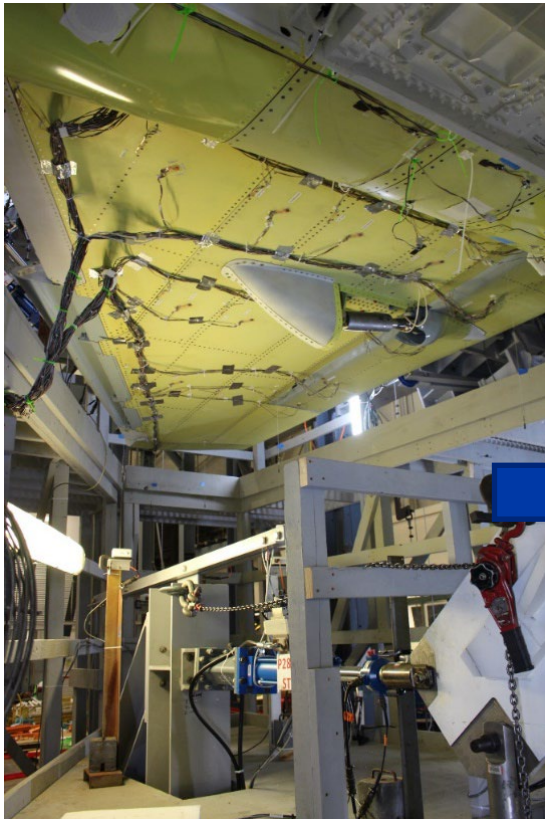


NLG

MLG

Fatigue Test: Tracking

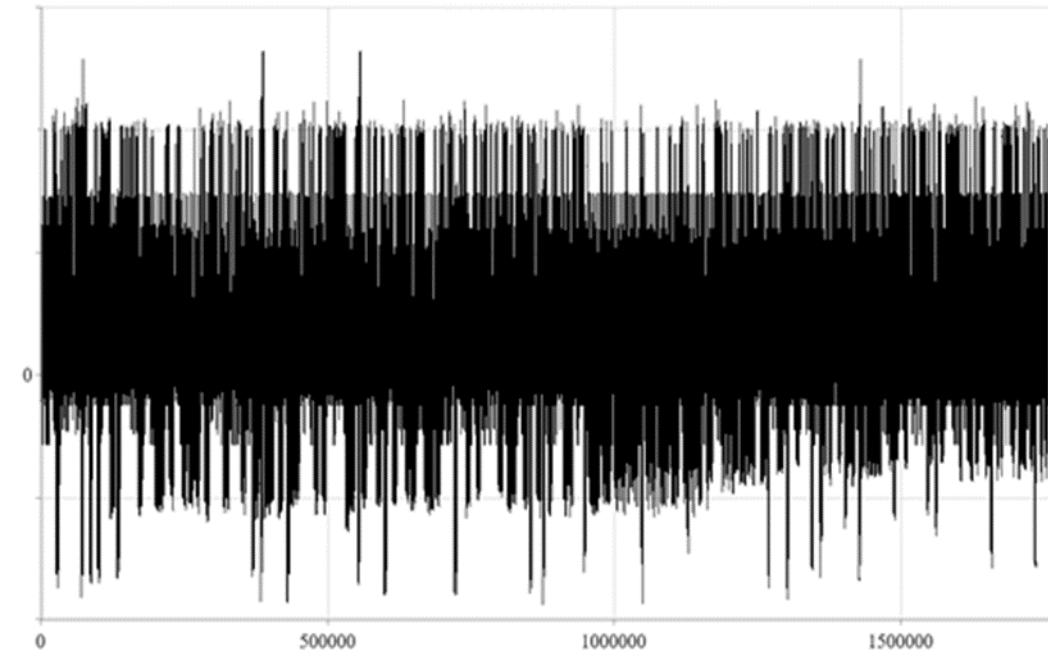
- Utilizing NCheck and NLign to capture fatigue test inspections and findings



Task III: FSFT Spectrum

- Test spectrum under development
 - Incorporating flight test correlated buff load data into spectrum which provides significant risk reduction for over/under testing
- Truncation of design spectrum is in work, necessary for practical test duration
 - Truncation of buffet load cycles is utilizing equivalent damage to reduce the required number of cycles
- Truncation and Marker Band verification testing in work
 - Test matrix covers representative materials and spectra
 - Validation of truncated spectrum derived from notched specimens
 - Marker Bands are added for correlation of failure analysis results

Spectrum Roadmap



Task IV: Certification and Force Mgmt Dev

Task V: Force Mgmt

Executing	Planning
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- Structural Certification is in work, Fatigue Test is up next
- Force Structural Maintenance Plan, Tracking System, and L/ESS Reports are in work
 - Usage data is not yet available to support these report items, however the framework is developed and has been delivered in some cases
- Leveraging lessons learned from legacy programs
- Task V on the horizon as aircraft are delivered and utilized

Task IV	Task V
Certification & Force Mgmt Development	Force Mgmt Execution
Structural Certification	L/ESS Execution
Strength Summary & Operating Restrictions	IAT Execution
Force Structural Maintenance Plan	Analytical Condition Inspection
Loads/Environment Spectra Survey System Development	Repairs
Individual Aircraft Tracking System Development	Force Mgmt Database Execution
Force Mgmt Database Development	Updates: DADTA, L/ESS & IAT, NDI, CPC & Corrosion, FSMP, Tech Orders, Structural Risk & Certification, Economic Service Life
Technical Orders	

Summary

- The T-7A Red Hawk is the USAF's new trainer, designed with a digital engineering mindset
- T-7A ASIP is currently executing Pillars II & III, progressing towards the full scale fatigue test
 - Leveraging digital engineering and lessons learned from the static test and legacy fatigue tests
- As the program matures, we are working on establishing a vigorous ASIP, to help ensure the safety, reliability, and structural performance of the aircraft for many years to come

Acknowledgements

- T-7A Fatigue Team
- T-7A IPT
- T-7A SPO
- T-7A FSFT Test Lab Team

Questions?

