

# ***Composite/Hybrid Structure Certification Overview and Challenges***

***2007 ASIP Conference***

***Mike Woodward  
F-35 Chief Engineers Office  
Lockheed Martin Aeronautics***



- **Certification Approach - Composite/Hybrid Structure**
- **Certification Details Relative to Composite/Hybrid Structure**
- **Certification Challenges – Strain Based Certification**
- **Certification Challenges - Implementation of Advanced Structural Concepts**
- **Summary**



- **Standard Approach Defined by ASIP**
  - ***Generation of Basic Material Allowables***
  - ***Element/Subcomponent Testing***
  - ***Structural Analysis***
  - ***Full-scale Test***
  - ***Flight Test***
  - ***Final Structural Analysis Update***
  - ***Generation of Force Management Source Data***

# **Certification Details Relative to Composite/Hybrid Structure**



- **Generation of Basic Material Allowables**
  - *Includes Temperature/Environmental Impacts*
  - *Includes Interlaminar Failure Modes*
  - *Includes Correlation of Structural Analysis Methods*
- **Element/Subcomponent Testing**
  - *Focus on Details Producing Significant Interlaminar Stresses*
  - *Producibility Issues Addressed at this Level*
  - *Performed at Critical Environment when Feasible*
  - *Includes Correlation of Structural Analysis Methods*

# **Certification Details Relative to Composite/Hybrid Structure**



- **Composites Related Structural Analysis**
  - ***Static Strength Checks***
    - **Bolted Joint Strength, In-plane Strength, Stability/Crippling, Interlaminar Strength**
  - ***Durability and Damage Tolerance***
    - **Compression After Impact, Min. Gage Requirement, Repairability, Effects of Defects, High Cycle Fatigue**
  - ***A/V FEM includes Hot/Cold Temperature Distributions - Induced Thermal Loads in Hybrid Structure are Accounted For***
- **Full-scale Static Test**
  - ***Focus is Demonstration of Structural Stability***
  - ***Test Performed RTD***
  - ***Includes Post-test Correlation of Measured Strains***

# **Certification Details Relative to Composite/Hybrid Structure**



- **Full-scale Durability Test**
  - *Test Performed RTD*
  - *Focus of Durability Test is on Metallic Structure*
    - *Does not Include Impact Damage or Implanted Defects*
      - *Considered too Risky: Failure could be Catastrophic*
      - *Demonstrated in Coupon/Component Tests*
  - *Includes Correlation of Test Failures*
- **Flight Test**
  - *Verifies External Loads, Environment, Flutter Resistance, Buffet Response*
- **Final Structural Analysis Update**
  - *Incorporates Required Updates in Internal and External Loads from Static Test and Flight Test and Correlation Results from Static and Durability Tests*



- **Our Primary Certification Challenge is Overcoming the Absence of Environmental Effects on Full-scale Test Articles**
  - ***No Environmental Knockdowns in Composite Structure***
  - ***No Induced Thermal Loads in Hybrid Structure***
- **Environmental Conditioning of Composite Structure and Performing Test at Temperature not Feasible Within Given Budget and Schedule Constraints**
- **Approach to Overcoming this Challenge is “Strain Based Certification”**
  - ***Demonstration of Adequacy of the Structural Analysis Without Full-scale Test Verification at the Critical Design Environment***

# Certification Challenges – Strain Based Certification



- **Strain Based Certification Accomplished Via:**
  - **Completion of Coupon, Component, Full-scale Ground and Flight Test Programs**
  - **Correlation of Structural Analysis with Coupon, Component, Full-scale Testing**
  - **Key Activity is Post-Static Test Strain Correlation Effort**
    - Verifies that the Air Vehicle Finite Element Model Predicts Correct Internal Mechanical Loads
    - Demonstrates Measured Structural Response is Consistent with Structural Analysis Assumptions
- **Successful Strain Based Certification is the Demonstration to the Certification Authority of the Validity of the Structural Analysis by Accomplishing Complete and Thorough:**
  - **Allowable, Component, Full-scale Test Programs and Correlation Effort**
  - **Flight Test Program**



# Certification Challenges - Implementation of Advanced Structural Concepts



- **Advanced Structural Concepts have Always been Proposed Early in Programs but Generally are not Implemented**
- **Implementation Roadblocks from a Programmatic Point of View are Based on:**
  - *Lack of Maturity when Structural Concepts are Being Defined Early in the Program – Viewed as Unacceptable Risk*
  - *Past Experience*
    - General Producibility and Rate Production Issues
    - Failure to Realize Promised Weight/Cost Savings
    - Certification Issues Associated with Inspectability and Manufacturing Variability
  - *Concerns with Robustness in Service Environment*
- **Funding and Development of Advanced Structural Concepts to a Sufficient Maturity Level Prior to Programmatic Need Dates Generally has not Occurred**



- **General Certification Process is Well Defined and Mature**
  - *Details of Process Determined as Structural Concepts are Defined*
- **Top Certification Challenge – Room Temperature Full-scale Tests**
- **Approach to Mitigate Full-scale Test Environment Exists via Strain Based Certification**
- **Strain-based Certification Accomplished by Demonstrating to the Certification Authority the Validity of the Structural Analysis and Stated Structural Capability via Complete and Thorough Test Programs and Test Correlation Efforts**