FAA Perspectives on Key Safety Issues

Presented on 9/13/05 at the Workshop for Developments in Composite Maintenance Training

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- Teamwork and disposition
  - Importance of realizing skill limits
  - Substantiation supporting approval
- Damage detection & characterization
  - Linking structural design and maintenance procedures in the building block approach
  - Anomalous damage scenarios
- Repair processes
  - Design and process detail differences
- Airbus/Boeing/FAA/EASA working group

Certification and Continued Airworthiness

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- Certification
  - Step 1: components of a product's design are qualified, conformed, and substantiated to get a ***Type Certificate*** (extensive FAA oversight)
  - Step 2: approval of the quality control system that ensures every product produced conforms to its type design leads to a ***Production Certificate***
  - During aircraft production and beyond, special design and production approvals are sought for changes, modifications, repairs, or improvements
  - Step 3: each aircraft must also have an ***Airworthiness Certificate***, which certifies it conforms to type design and is in safe operating condition
- Service problems are addressed with industry during the aircraft's life

Data, analysis & procedures defining the aircraft product and demonstrating it meets Federal Regulations

Repeatable production of certified aircraft products

Additional info may be needed for changes occurring during production or the product life cycle

Teamwork and Disposition

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- Unique modules with critical safety messages
  Module C: *Understand roles and responsibilities*
  Module E: *Identify & describe info contained in documentation*
  Module K: *Case team studies [Lab #6]*
- Successful maintenance & repair relies on teamwork
  - Engineers, inspectors & technicians have diverse training needs and acquired skills
  - Good communication between OEM and users
- Approved maintenance practices and repair procedures are developed & substantiated to meet requirements
  - Specific product design, process and database dependence
  - Limits and constraints of approved source documentation

Damage Detection & Characterization

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- Essential modules for detecting and solving a problem
  Module D: *Recognize composite damage types and sources*
  Module H: *Describe composite damage and repair inspection procedures*
- Working outside the limits of approved documentation
  - Difficult to substantiate repair of all possible environmental and accidental damage cases in initial type certification
  - Standard designs, analyses & shared databases don't exist to support the substantiation of composite field repairs
- Some damage scenarios require special inspections
  - Communication between operations, maintenance and OEM personnel for anomalous damaging events

What is a “Building Block Approach”?

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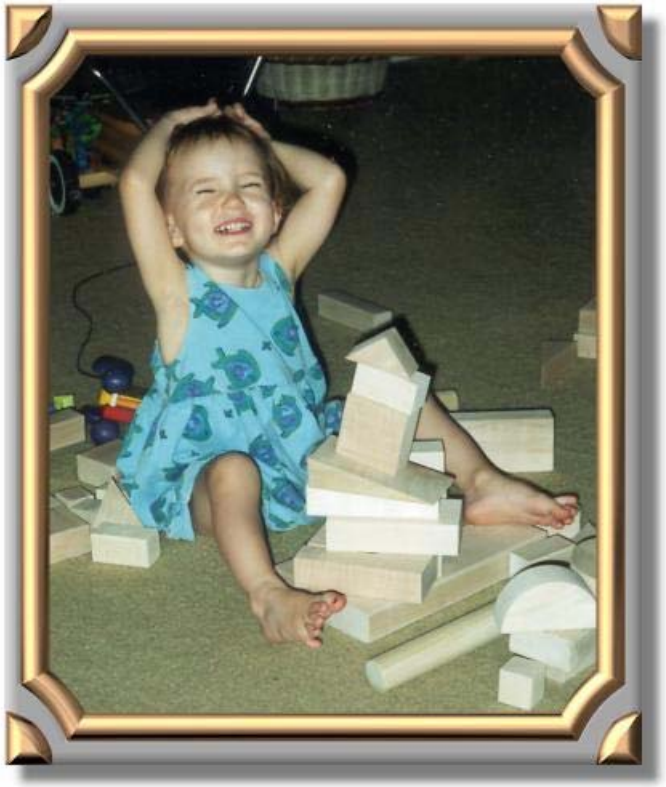
A Terminology used by composite engineers to help ensure those having a metals background proceed with caution.

B “Structural substantiation process, using both testing and analysis in a program of increasingly complex levels.”

C Development and certification approach to integrating design, manufacturing and maintenance

D All of the above



Structural Substantiation
Critical Issues for Composite Designs

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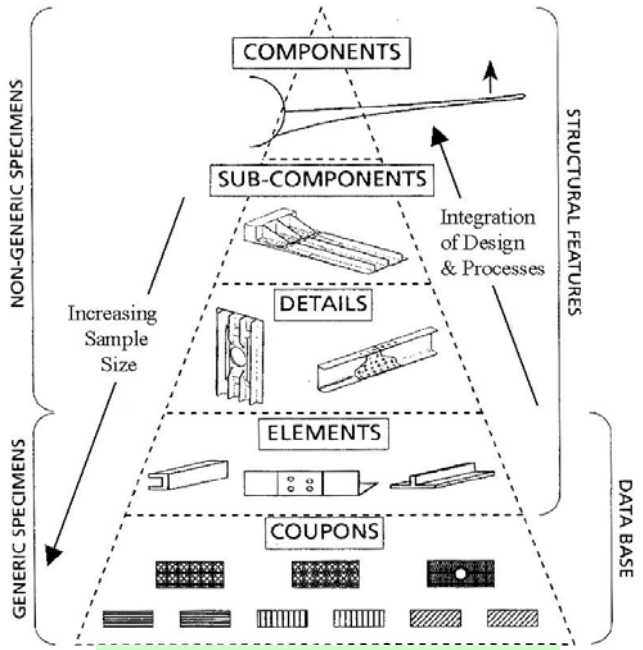
- *Integration of structural design detail with repeatable manufacturing processes*
  - Material and process control
  - Traditional building block test & analysis approach is difficult for some new processes
- Design details, manufacturing flaws and service damage, which cause local stress concentration, drive static strength MS
  - Dependency on tests (statistical basis)
  - Scaling issues
- Environmental effects
  - Temperature and moisture content
- Repeated load and damage tolerance considerations
- Maintenance inspection & repair (considering the above issues)



Building Block Tests & Analysis

Repair Processes

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- Modules needed to realize critical issues in composite repair processes and quality control procedures
  - Module F: *Describe composite laminate fabrication and bonded repair methods*
  - Module G: *Perform bonded composite repair*
  - Module I: *Describe composite laminate bolted assembly & repair methods and perform/inspect bolted repair*
- Hands-on labs, videos and testimonials help gain an appreciation for process-related safety messages
- Design and process detail differences are likely in advanced, product-specific, “how-to” training

Baseline versus Evolving Composite Technologies

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- Baseline composite manufacturing technology uses pre-impregnated material forms for lamination
  - Critical process steps:
    1) Material controls, storage and handling
    2) Laminate lay-up
    3) Component cure
    4) Machining (cutting, drilling, sanding and finishing)
    5) Bolted and/or bonded assembly
    6) Inspection

    Order may change in specific process steps for each element and assembly
- Industry is pursuing some advanced processes to increase production rates & reduce manufacturing cost
  - Automation (laminate lay-up, machining, assembly, ultrasonic inspection)
  - Liquid composite molding
  - Thermoplastic forming
- Maintenance technology needs for advanced processes?

Repair Processing Factors that can affect Structural Properties (Safety-Critical)

Continuous control of key process steps

- **Selection of compatible & qualified repair materials**
- **Some raw materials are perishable and require environmental controls (storage and use)**
- **Part handling controls to avoid accidental damage**
- **Proper part drying and surface prep for bonding**
- **Eliminate contamination in repair lay-up & bonding**
- **Use of appropriate tooling**
- **Accurate repair lay-up and bagging**
- **Systematic control of repair cure/consolidation**
- **Proper machining and bolted repair installation**
- **Training of maintenance technicians**

Boeing/Airbus/FAA/EASA WG for Damage Tolerance and Maintenance

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- Composite structural damage tolerance & maintenance practices are closely associated and critical to safety
  - Unique considerations versus metal structure
  - Some differences in the approaches used by OEM
- Expanding transport applications justify more open communication on composite damage tolerance and maintenance within industry & regulatory bodies
  - Lack of trained resources with practical experiences
  - Cost advantages from more common & efficient procedures
- Operations and maintenance personnel must properly react to all potential types of service damage

Boeing/Airbus/FAA/EASA WG for Damage Tolerance and Maintenance

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- Objectives
  1) To agree on the critical technical issues and areas of safety concern for aircraft damage tolerance & maintenance
  2) To compare & contrast methods used to substantiate damage tolerance for transport aircraft structures
  3) To review the development & implementation of maintenance inspection and repair procedures
  4) To document appropriate engineering guidelines and maintenance training standards that support safety
  5) To identify other standard needs for future working groups
- Several working group meetings over the next year
  - Users (airlines, MRO and regulatory inspectors) will be involved and review draft documentation before release