ICAS – The International Council of the Aeronautical Sciences

ICAS Biennial Workshop – 2011

Advanced Materials and Manufacturing – Certification and Operational Challenges

Programme Committee Chairman – Murray L. Scott

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Key Messages – Richard Minter

- Must ensure that a change to composite does not degrade the level of safety provided. This can be achieved by showing equivalent or better behaviour to that of a comparable metallic design and ensuring all realistic threats are addressed.
- Specific issues that deserve particular attention are: crashworthiness; design and certification of bonded structure, including repairs and the type and extent of failures to be considered; blunt impact; and training.
- The Agency endeavours to take a proactive approach to safety, trying to anticipate potential issues.
- Research and participation in various international working groups is supporting the certification and CAW process by increasing our knowledge of the key issues for composites (but our resources are limited).
- Industry should expect more questions whilst our collective experience grows, yet remains limited compared to metallic structures.

Key Messages – Frank Doerner

- Speed – need to develop, certify and qualify new technologies faster
- Leveraging the materials and manufacturing technologies with advanced configurations
- Reducing the environmental impact – to build, operate & dispose
- Global partnering
- Cost, cost, cost

Key Messages – Christophe Brand

- Still huge potential of improvement for composites
- Innovative approach involving the extended enterprise needed

  1. to increase industrial maturity
  2. to develop multi-functional approach from Day 1
  3. to ensure a sustainable development of this business

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Key Messages – Toshio Abe

- Composite application on airframe has been increasing
- Typical examples are Boeing 787 & A350XWB
- Composites cannot currently demonstrate prominent advantage in cost & weight in small commercial airplane, such as MRJ
- Technical challenge against weight reduction
- Recurring cost challenge
- Need game-changing technology to obtain prominent advantage

Key Messages – Takashi Ishikawa

- Increase of composites percentage in aero-structures
- Recent two major challenges: B-787 and A350
- Precious lessons learned: Delay and cost issues, unexpectedly low weight reduction, increase?
- Proposal for Development Cost Reduction
  - Substitution of some steps in BBA by “Virtual testing”
  - “Virtual processing”: out of scope, today
- Example: Lower panel of VaRTM wing test, potential of future substitution of BBA steps by simulation
- Example: Lightening strike damage: difficult & costly tests, at a gateway of accurate numerical simulation
- If high development costs remain in composites, aircraft industries may go back to aluminum again!

Key Messages – AR Upadhya

- Development of technology for composite tools, substructures and their integration.
- Technology for integrated construction of large complex structures.
- Developed the VERITy process for large co-cured (co-infused) structures.
- High level of co-curing technology achieved.
- Composite structures for LCA-Tejas have entered production phase – trouble-free
- Capability to conceive, design / analyse, develop and certify primary aircraft structures using composites.
- Development of SHM technology for load monitoring of structures using fibre optic sensors. Damage Monitoring work in progress.
- Taken SHM technology to aircraft level. Successfully conducted flight trials all-composite 2-seater aircraft and UAV.
- Development of Fibre Optic Sensor for real-time flow visualization during infusion.
- R&D in the areas of Fibre Metal Laminates (FML), Thermoplastic Composites, Nano Composites, 3D Composite Technology for fittings and cocured structures.

Key Messages – Pontus Nordin

- Composite designs based on current generation toughened prepreg materials are mainly driven by limitations in CFRP fracture toughness, matrix-controlled mechanical properties and manufacturing issues related to anisotropy.

- Future multi-functional airframes will use extensive structural integration and new technologies. Such airframes will be significantly more challenging to develop and certify. Their realization will require materials, designs and manufacturing methods, including new NDI, to ensure the necessary improved quality, damage tolerance and new functionality.

- Emerging technologies for nano-engineered inter- and intra-laminar strength improvements and toughening, based on CNT, etc., have progressed significantly.

- Development and certification of nano-engineered CFRP unitized structures (and/or alternative technologies) will be challenging, but potential operational improvements include both cost and weight efficiency as well as improved durability and related effects.

- The ongoing development of CFRP structures calls for a corresponding improvement of relevant analysis methods, eg. regarding multi-scale modelling of nano-engineered materials.

Key Messages – Richard Degenhardt

- Areas for R&T developments at the DLR Institute of Composite Structures and Adaptive Systems include:
  - Multifunctional materials, Structural mechanics, Composite design, Composite technology, Adaptronics, Composite Process Technology
- Unstiffened CFRP structures: proposal for a new design concept
  - The current NASA SP 8007 design guideline does not take the potential of CPRP structures into account. A new promising concept is proposed.
- Stiffened CFRP structures:
  - Exploitation of reserve capacities of stiffened CFRP in the postbuckling area
  - Improved consideration of dynamic effects

Conclusion – Murray Scott

- There is now a long history of successful application of composites in aircraft dating back over 40 years, eg. Saab 105 rudder trim tab (1971)
- The significant increase in the application of advanced composites in large civil transport aircraft holds great promise over the coming decades
- The introduction into service next month of the Boeing 787 with a 50% composite airframe will provide significant operational cost savings
- Further advancements will require close cooperation with Certification Authorities to ensure key issues are addressed during development
- The reduction in costs associated with the design, development and manufacture of composite structures at very high rates, is now critical
- Significant advances in computational analysis, and multi-scale simulation in general, offer potential for both manufacturing and testing cost savings
- The development of multi-functional structures, including structural health monitoring, will lead to overall performance and other improvements
- Utilisation of advanced metallic materials, such as Aluminium-Lithium alloys, will continue to increase, thus contributing further cost and weight savings

ICAS – The International Council of the Aeronautical Sciences

ICAS Secretariat

c/o DGLR, D-53175 Bonn, Germany

Phone: +49.228.3080519; Fax: +49.228.3080524

E-mail: icas@icas.org; Web: www.icas.org

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