• Chairs:
  • T. Kevin O’Brian - ARL/VTD at NASA Langley Research Center
  • Keith Kedward - University of California at Santa Barbara
  • Hyonny Kim - Purdue University

• Write handbook sections
  • Fracture Toughness Testing - James Reeder, NASA LaRC
  • Fatigue Testing - Isabelle Paris, Composites Innovations Inc.
  • Fatigue Damage Onset - T. Kevin O’Brian, ARL/VTD at NASA LaRC
  • Damage Growth under Cyclic Loading - D.M. Hoyt, NSC Composites
  • VCCT - Jeff Schaff, Sikorsky Aircraft

• Interface with ASTM Committee D30-06 on Interlaminar Properties
  James Reeder, NASA LaRC
• A methodology based on fracture mechanics was demonstrated for a laboratory size coupon type specimens based on airframe components

• Fracture toughness testing for static and cyclic loading was discussed

• Virtual Crack Closure Technique was applied during analysis of to skin/stringer debond problem

• Feasibility of shell/3D modeling technique was demonstrated

• Shell/3D modeling technique likely to offer accurate results and affordable computational effort for models of large built-up composite structures

• Methodology is maturing, however until recently has only been used in a research environment - not during design or certification.
OUTLOOK
LARGE SCALE VERIFICATION OF METHODOLOGY

testing

characterization specimen → coupon test → structural component

increased complexity

full 3D model of DCB specimen

local 3D model of delaminated section

global shell model of unfractured section

local 3D model of delaminated section

analysis
OUTLOOK
SHELL FE-MODEL WITH LOCAL 3D INSERT

shell replaced by local 3D model (C3D8I)
OUTLOOK
USE OF ADVANCED STRUCTURAL COMPOSITES

- Boeing 7E7
  - Planned 50% of structural weight consists of advanced composites
  - Substantiated analysis methods reduce testing
  - Application of fracture mechanics for structural analysis of composite parts
  - Development of VCCT interface element. Integration into ABAQUS announced for the end of 2004
WORKSHOP SUMMARY
Computational Fracture Mechanics for Composites

- Held in Salt Lake City, UT, March 22-23, 2004 in conjunction with ASTM Committee Week and ASTM Committee D30 meetings
- 19 presentations in four sessions
- Two discussion sessions
- 80 participants from
  - United States, Canada, Belgium, Denmark
  - Aircraft Industry, Government, Software Companies, Composite Industry, Consultants, Research Institutes, Universities
- Brought together representatives from academia, industry, government, software companies and certifying authority
- Discussed one single topic: Computational Fracture Mechanics for Composites
- Discussed a road map to certification
- Made FE software developers aware of customer needs
- Announced ABAQUS/Boeing collaboration on VCCT routine
REMAINING CHALLENGES

• Complete development of test standards for delamination fracture toughness testing

• Develop test standards and methodology for fatigue delamination growth

• Define fracture mechanics benchmark tests for FE software developers

• Consider methods other than VCCT to calculate/compute mixed-mode strain energy release rates

• Include methods such as damage mechanics and progressive failure to determine the damage state of a composite structure

• Get other industries (automotive, marine) interested and involved