



# DETECTION AND SIMULATION OF CRACK GROWTH FOR BOEING-787 AIRCRAFT COMPOSITE WING

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# Agenda

- Introduction
- Problem Definition
- Counter Measures
- Technical Challenges
- Research Objectives
- Methodology
- Future Results and Deliverables
- Acknowledgments

# INTRODUCTION

- AGING OF COMMERCIAL AIRCRAFT IS CRITICAL ISSUE FOR PASSENGER SAFETY
- THREATS AND VULNERABILITIES INCLUDES: WEATHER, FLUTTER, AND WIND LOADINGS
- COUNTER MEASURES INCLUDE: FRACTURE MECHANICS ANALYSIS

# PROBLEM DEFINITION

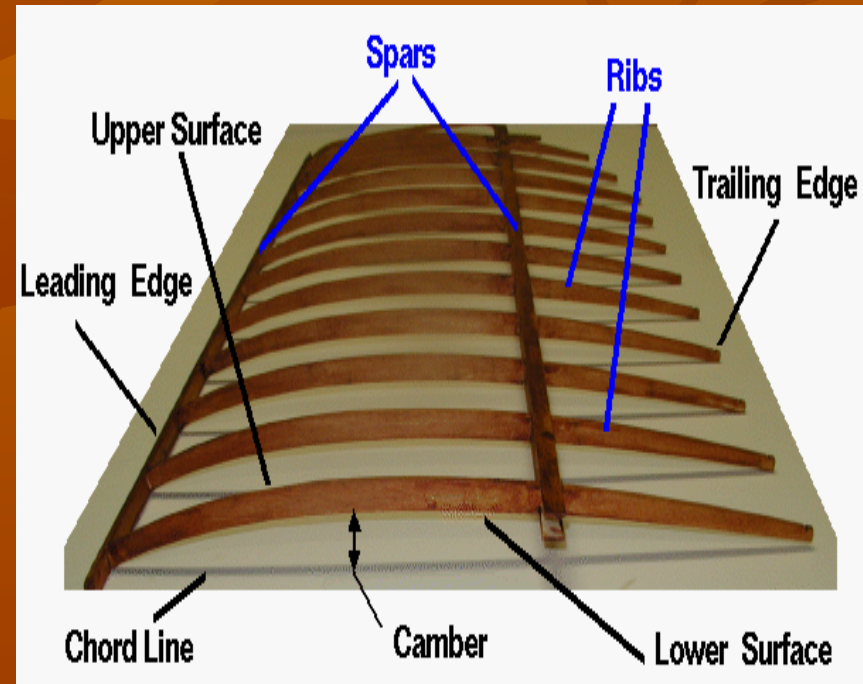
- THE BOEING 787 HAS BEEN SELECTED TO PERFORM FRACTURE ANALYSIS ON ITS COMPOSITE WING
- THE BOEING 787 WILL BE THE LARGEST AIR VEHICLE IN THE COMMERCIAL TRANSPORT SECTOR
- THE WING WHICH IS 170 FEET IN LENGTH AERODYNAMICALLY SUPPORTS THE MAJORITY OF THE LOAD DURING FLIGHT
- RESIDENT MATERIAL IMPERFECTIONS WILL BE MODELED WITH THE FINITE ELEMENT MODELING METHOD (ANSYS) AND WITH FRACTURE MECHANICS THEORITICALLY AND EXPERIMENTALLY.

# COUNTER MEASURES

- COMPOSITE MATERIALS ARE THOSE CONTAINING MORE THAN ONE BONDED MATERIALS WITH DIFFERENT STRUCTURAL PROPERTIES
- ANSYS AND FEM WILL ALLOW ONE TO MODEL CRACK GROWTH AND PROPAGATION PREDICTING ADVERSE AGING WING FAILURE

# TECHNICAL CHALLENGES

- SECURING PROPRIETARY BOEING COMPOSITE MATERIAL PROPERTIES
- OBTAINING CURRENT BOEING COMPOSITE VIRGIN EXPERIMENTAL DATA
- MORGAN STATE UNIVERSITY WILL COLLABORATE WITH NASA OFFICIALS TO OBTAIN THIS DATA



# AIRCRAFT ATTRIBUTES

- Seating 290 to 330  
Passengers
- Range: 3,050 mi.
- X-section: 226 inches
- Wing Span: 170 ft.
- Length: 186 ft.
- Height : 56 ft
- Speed: Mach .85
- Entry Service: 2010
- Take Off Wt.: 364,000 lbs



Boeing 787, Dreamliner

# NEEDS ASSESSMENT

- APRIL 28, 1988 MULTIPLE FATIGUE CRACKS (737-200) AIRCRAFT LOST PART OF FUSELAGE (1 LIFE LOST)
- MAY 9, 2005 ROCKWELL INTERNATIONAL MODEL SHJ-6(AT-6F) AIRPLANE CRASH LARGE FATIGUE CRACK (2 FATALITIES)
- 1988, ALOHA AIRLINES 737 MICRO-CRACK (3 CRITICALLY INJURED)

# RESEARCH OBJECTIVES

- TO IMPROVE COMMERCIAL AIR SAFETY (PASSENGER) THRU MULTI-PHYSICS ANALYSIS
- TO ACCURATELY MODEL CRACK PROPAGATION IN VIRGIN COMPOSITE MATERIAL
- TO OBTAIN THEORETICAL RESULTS THAT CAN BE VALIDATED THROUGH EXPERIMENTATION

# RESEARCH METHODOLOGY

- The Elastic Plastic Fracture Mechanics Methodology has evolved significantly in the last several years.

Specifically, there is a need to include the effect of constraint in the characterization of material resistance to crack growth and also to extend these methods to the case of 3D defects.

As a consequence, this project is a research program with the general objective of utilizing an elastic plastic fracture mechanics methodology to assess the structural reliability of materials that contain flaws.

# FUTURE RESULTS AND DELIVERABLES

- CRACK GROWTH CALCULATIONS
- STRESS RESULTS ASSOCIATED WITH CRACK GROWTH
- ANSYS INPUT/OUTPUT FILES
- RECOMMENDATIONS THAT WILL MINIMIZE CRACK GROWTH AND INCREASE AIR SAFETY
- PUBLICATION

# Final Remarks

- Software and hardware has been delivered
- We look forward to this technical challenge.

# Acknowledgments

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# QUESTIONS

