The O.U.R 2024 Fall Conference

GUEST SPEAKER

David A. Jack, Ph.D

Professor of Mechanical Engineering; Program Director of Materials Science and Engineering, Baylor University

9:00 to 9:50 am – November 15, 2024

Galloway – Business bldg. – Landes 101

SHORT BIOGRAPHY:

Dr. David Jack, professor of Mechanical Engineering at Baylor University, founded Baylor's ISO 17025 test lab. He helped to establish Baylor's PhD program in Mechanical Engineering and established the PhD program in Materials Science and Engineering. He has authored more than 150 journal and conference publications, holds twenty patents, and produced twelve FAA 8100-9 certifications. His team specializes in next-generation material systems from the sub-micron to full-scale aircraft to oil and gas well mitigation. His expertise crosses physics-based constitutive modeling, composites characterization, and non-destructive testing and inspection. His group is known for their expertise in numerical modeling and characterization of polymer systems and are pioneers in high-resolution non-destructive testing methods. He has been awarded over $19.2M in externally sponsored research, $12.4M as the lead investigator.

LECTURE: Establishing the Digital Twin from Nondestructive Inspection Data for Composite Analysis

The use of carbon fiber reinforced materials has become mainstream in the aerospace, automotive, and sporting industries due to their versatility, performance, and high strength to weight ratio. Parts are often designed under a defect-free assumption, and then a factor of safety approach is imposed to allow for unknown manufacturing variabilities. The present work presents a new approach where internal features, often termed defects, are captured using non-destructive techniques and then incorporated into a finite element simulation allowing for inspection informed digital twin modeling. The talk highlights some of the current work by the research team at Baylor University to quantify using non-destructive testing of a variety of common manufacturing induced and service induced defects. This work presents a novel method to nondestructively characterize the internal features within a laminated composite, and then feed the features into a finite element model domain to estimate the true, not necessarily the as designed, part performance. Inspections are performed using high-frequency ultrasound to create a three-dimensional image of internal features, and results are compared to those from micro-X-ray computed tomography and are in excellent agreement. The characterized three-dimensional features are then incorporated into a finite element model domain, and the finite element results for the strain field are then compared to results of the strain field during loading from digital image correlation (DIC). The novelty of the presented method is the combination of physical testing, non-destructive testing for the geometric extraction, to structural predictions using the inspection data directly thus closing the loop of the true digital twin.

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