

ASSURING AERO-STRUCTURAL RELIABILITY IN AN UNCERTAIN WORLD

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ABSTRACT

The capability to repeatedly “go-high, go-far, go-fast” and to do this on-demand with reusable platforms is one that the United States Air Force has sought, unsuccessfully, for over half a century. This plenary talk will enumerate the key technical challenges from a structures perspective, and will detail some of the ongoing efforts within the US Air Force Research Laboratory, amongst its academic partners, and by the US aerospace industrial base, that are being collectively and synergistically vectored towards making this long-desired capability a reality. Particular emphasis will be placed on some of the major challenges associated with predicting structural performance for platforms flying in environments that are not always well understood and in which we have little operational experience. These challenges include: the prediction of structural response within desired uncertainty bounds when the loads driving that response are not always known precisely; the need to rely on coupled multi-physics structural response prediction models that are invariably uncertain because the single-discipline/single-physics models being coupled together are either of varying fidelity or have differing levels of accompanying uncertainty, or both; and the need, for efficiency, to use continuum-level descriptors of the continuously-evolving material state and hence, the progression of the structure towards one or more limit states, when these descriptors are not readily available for the combined extreme environments of interest. The ultimate objective? A full-platform, uncertainty-quantified, structural simulation, i.e., a ‘Digital Twin’ that reliably predicts the structural margins for platforms that encounter intense, highly-coupled, aero-thermo-acoustic operating environments for extended durations, as these platforms undoubtedly will.

THE SPEAKER

Dr. Ravi Chona, a member of the Senior Scientific & Professional Service of the United States of America, is a US Air Force Senior Scientist and the Director of the Structural Sciences Center at the Air Force Research Laboratory, a senior leadership position he was recruited to from academia in 2003. At AFRL, he is charged with ensuring that the US Air Force possesses the cutting-edge aero-structural solutions essential to fielding revolutionary air and space platforms that can assure the air dominance required by the national security and strategic needs of the United States. Previously, he was a member of the Mechanical Engineering Faculty (1987-2003) and the Director of the Institute for Innovation and Design in Engineering (1999-2003) at Texas A&M University. He earned his BS, MS, and PhD degrees in Mechanical Engineering at the University of Maryland, College Park, and enjoyed the unique privilege of having as his graduate advisor and mentor, the late Professor George R. Irwin – the founding father of engineering fracture mechanics.

Dr. Chona’s professional contributions have been recognized via: the NSF-Presidential Young Investigator Award (1991); a Select Young Faculty Award (1992) and Departmental (1997) & College (1998) Teaching Awards at Texas A&M; election as a Fellow of ASTM International (2000), election as a Fellow of the ASME (2001), and election as a Fellow of SEM (2002); the George R. Irwin Medal for Outstanding Contributions to the Theory and Practical Applications of Engineering Fracture Mechanics from ASTM International (2003); the Presidency of the Society for Experimental Mechanics - SEM (1997-1998); the Chairmanship of ASTM International’s Committee E08 on Fatigue & Fracture (2006-2011); Membership on the US National Committee on Theoretical & Applied Mechanics (2001-2009); Membership on the Executive Board of ICF-

WASI: The International Congress on Fracture & World Academy of Structural Integrity (2009-present); Editorial Board Membership for several journals, including *Experimental Mechanics* and *Fatigue and Fracture of Engineering Materials and Structures*; and the position of US National Delegate on the International Committee on Aeronautical Fatigue & Structural Integrity - ICAF (2006-present). He is one of a select few of the 7,000+ senior civilian leaders in the Executive Branch of the US Government that has been recognized through a Presidential Meritorious Senior Professional Award (2010).

