

Modern gas turbines are designed to meet the demands of higher efficiency and reduced emissions while maintaining the safety standards expected through certification. In order to meet these standards and improve designs, robust testing and prediction methodologies are required to ensure the structural integrity of key mechanical components in the engine. Such components

typically see combined thermal, mechanical, and vibratory loads and traditional single-parameter tests are insufficient to support the need to optimize designs and evaluate structural integrity

meaning that components such as shafts, casings and other components must be evaluated under multi-axial stresses, high-cycle fatigue, creep, and thermal gradients that interact in non-linear ways. This talk presents an overview of the capabilities and advancements at the University of Nottingham for the mechanical testing of gas turbine components, emphasizing the integration of

laboratory experimentation with modelling and predictive tools. We discuss the design of test rigs capable of reproducing representative conditions and measurement techniques that are used to generate results for the validation of models. Emphasis is placed on the importance of tailoring boundary conditions, load spectra, and thermal cycling protocols to match those derived from engine mission profiles. Case studies are presented to illustrate how representative-condition testing provides insights not captured by analytical models alone. The talk will highlight ongoing challenges, including scaling effects when moving from material to component testing.

Approaches such as the coupling of structural tests with high-fidelity models and methods for accounting for uncertainty are discussed as promising pathways to improve reliability and reduce development cycles. By demonstrating the necessity and value of structural testing under representative conditions and the methodologies described not only support the evaluation of

current designs, but also provide critical validation for innovative designs, materials, and manufacturing processes that will define the next generation of propulsion systems.