Design Environment for Multifidelity and Multidisciplinary Components

An integrated framework for turbomachinery analysis

One of the greatest challenges when developing propulsion systems is predicting the interacting effects between the fluid loads, thermal loads, and structural deflection. The interactions between technical disciplines often are not fully analyzed, and the analysis in one discipline often uses a simplified representation of other disciplines as an input or boundary condition. For example, the fluid forces in an engine generate static and dynamic rotor deflection, but the forces themselves are dependent on the rotor position and its orbit. It is important to consider the interaction between the physical phenomena where the outcome of each analysis is heavily dependent on the inputs (e.g., changes in flow due to deflection, changes in deflection due to fluid forces). A rigid design process also lacks the flexibility to employ multiple levels of fidelity in the analysis of each of the components.

This project developed and validated an innovative design environment that has the flexibility to simultaneously analyze multiple disciplines and multiple components with multiple levels of model fidelity. Using NASA's open-source multidisciplinary design analysis and optimization (OpenMDAO) framework, this multifaceted system will provide substantially superior capabilities to current design tools.

Applications

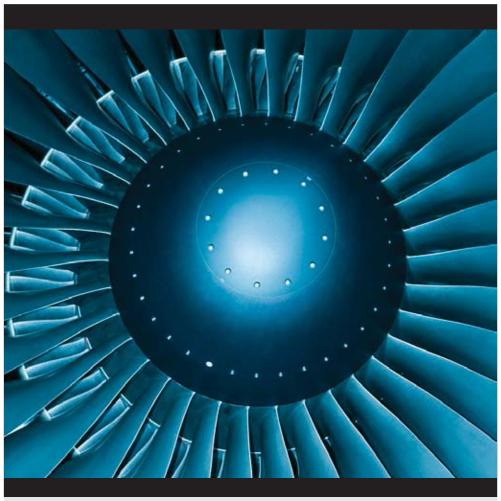
NASA

- Integrated framework for turbomachinery analysis
- Multifidelity physics-based tools
- Numeric zoom functions in numerical propulsion system simulation (NPSS):
  - Fluid-structure interaction capability
  - High-fidelity analysis and optimization in OpenMDAO

Commercial/Military

Enhanced design and development of:

- Gas turbine engines
- High-performance turbomachinery



Phase II Objectives

- Develop and validate the modeling architectures for fluid structure interaction (FSI) analysis
- Develop FSI capability in NASA computational fluid dynamics solver and commercially available solver
- Verify and validate the functions for numeric zoom, FSI, multidiscipline, and multifidelity analysis

Benefits

- Improves design analysis process of a wide range of high-performance turbomachinery (gas turbine and chemical propulsion, power generation, oil and gas)
- Reduces failure rate and development cost of turbo-machinery systems
- Reduces time and complexity of multiphysics analysis (e.g., job setup, solution control, pre- and postprocessing)

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