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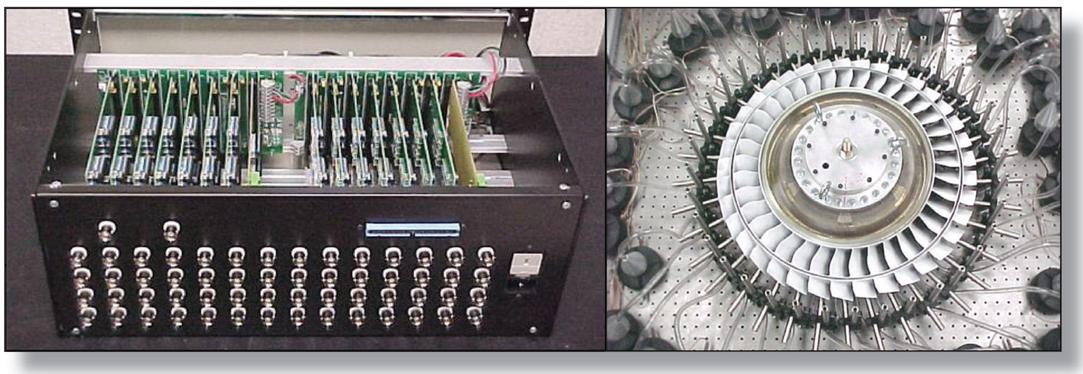
Success Story

TEST MODIFICATION PREVENTS IHPTET DELAYS



A team of engineers and scientists in the Propulsion Directorate's Turbine Engine Fatigue Facility (TEFF) kept a national collaborative program on track by expanding and modifying their test hardware to measure a one-of-a-kind engine component, all without significant cost. The TEFF Team completed the entire test program in the 2 weeks between engine tear down and the required delivery to the machine shop for modification.

The team's quick response in making the necessary modifications to the test and data acquisition systems provided high-fidelity data to the program without any adverse effects on the planned schedule. The TEFF Team maintained the test schedule for the XTC 76/3B, which is critical to reaching Integrated High Performance Turbine Engine Technology (IHPTET) Phase 3 goals as demonstrated through the XTE 77/1.

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Accomplishment

The TEFF Team of engineers and scientists developed and implemented a redesign to their traveling wave excitation system in order to support the third phase of the IHPTET program. The team used the excitation system to measure high response resonant modes with laser scanning vibrometry and test the unique core-driven fan stage (CDFS) of the XTC 76/3 demonstration engine.

In less than 6 weeks, directorate engineers redesigned and expanded the excitation system electronic circuitry from 18 to 37 necessary channels for the experiments. They also expanded the laser scanning vibrometry capability—in both number of excitation channels and laser scan field-of-view—to enable coverage of the 40-inch bladed disk (blisk).

Background

The CDFS is a unique integrally machined blisk stage incorporating two distinct stacked blade rows in a single stage. This design is unique to General Electric Aircraft Engines and Allison Advanced Development Company and is one of only two components of this type ever produced.

Due to its geometric features and unique design, conventional finite element analysis and laser vibrometry produced inconsistent results. Since large amplitude vibrations were experienced in the 1st flex (trailing edge dominated) mode at partial power and the 2nd stripe mode near maximum power during engine testing, directorate engineers needed insight into the structural dynamics characteristics of the entire blisk to ensure proper redesign and modification by the manufacturer. Directorate engineers required complete testing to avoid large amplitude resonances when the engine returns to test as the XTC 76/3B in early fiscal year 2003.

Using acoustic excitation, directorate engineers performed chirp tests covering a frequency range of 0 to 9000 Hz on both the fan and the core airfoils. The engineers used the scanning vibrometer to obtain the dynamic response characteristics of all airfoils, on both inner and outer panels, for all resonant modes that exist in the operating range of the engine.

Directorate engineers also measured mistuning patterns, stress localization, and phase relationships between inner and outer panels. The data obtained in this test program validated the intended modifications to the blisk and permitted the return to the demonstrator engine safely and expeditiously.

Propulsion
Emerging Technologies

Additional information

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