

DEPARTMENT OF MECHANICAL ENGINEERING AND MATERIALS ENGINEERING
COLLEGE OF ENGINEERING AND APPLIED SCIENCES

SUMMER RESEARCH OPPORTUNITIES FOR UNDERGRADUATE students

FOR APPLICATION YEAR: 2022

PROJECT TITLE: Experimental Vibration Study of Additively Manufactured Parts with Internal Damping Features

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Project Description

Background: This project is a collaboration between the Turbine Engine Fatigue Facility (TEFF), part of the Air Force Research Lab (AFRL) at Wright Patterson Airforce Base near Dayton Ohio and Dr. Kiracofe in Mechanical and Materials Engineering.

Failure due to high cycle fatigue remains a major design consideration for critical aerospace systems. Additively manufactured parts, while having many benefits over conventionally machined parts, typically exhibit worse fatigue properties. Recently, researchers at AFRL have been experimenting with incorporating damping elements directly inside additively manufactured parts. The increased damping reduces vibration amplitudes and thus greatly improves a part's life. The basic concept has been demonstrated to reduce vibration amplitude by an order of magnitude, but further work is needed to move this technology from the lab into real jet engine components.

Project description: The student will perform experimental vibration measurements on various additively manufactured parts with internal particle dampers to characterize the dynamics (e.g. the damping ratios) and/or fatigue life. This will include the student learning how to conduct experimental vibration tests using a 6k electro-dynamic shaker and laser vibrometer. The goal will be to determine the effects of various parameters in order to optimize the design of turbine engine relevant components.

The majority of experiments would be conducted at WPAFB in Dayton Ohio using equipment in the TEFF lab. The student will be on base for the majority of the summer (3-4 days per week, assuming that there are no COVID restrictions) and on campus in Cincinnati the remaining days of the week. The student would interact with AFRL researchers on a regular basis.

Learning objectives: The student will learn:

- Experimental procedures for characterizing linear and non-linear dynamics

of structures (e.g. natural frequencies, mode shapes, damping ratios, etc) and high cycle fatigue life.

- Use of experimental vibration equipment including shakers, impact hammers, accelerometers, strain gages and laser vibrometers.
- Use of Matlab or Python for data analysis.
- Basic concepts of additive manufacturing using laser powder bed fusion process.
- Basic concepts of high cycle fatigue.

Restrictions: The student must be a US citizen.