Innovative Solvers Address UAV Airframe/Propulsion Integration

Project Purpose: *The goal of this project is to investigate the inlet/fan interaction adaptive propulsion system applications using High Performance Computers (HPCs) coupled with real-world experiments.*

A Disturbance in the Flow

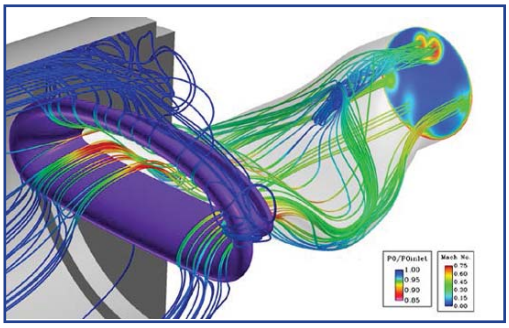
Unmanned Aerial Vehicles (UAVs) are increasingly used in military applications. Future UAV designs will include system integration for increased reliability and efficiency. Currently, researchers use the HPC environment to assist their goal of system integration analysis for UAVs by performing high-fidelity coupled simulations of integrated systems and providing visualized results of the computations.

The current research group of Michael List, Dr. Darius Sanders, and Rebecca Howard of the AFRL Propulsion Directorate at Wright Patterson AFB, has taken on the challenge to discover the physics associated with the interactions between the complex flows in a serpentine inlet diffuser and the front fan stage of a turbine engine.

A UAV's engine is internal, requiring an inlet duct to deliver airflow to the engine. As future UAVs become smaller to reduce cost and weight, the inlet diffuser must become more serpentine to accommodate the shorter fuselage. The serpentine inlet diffuser generates a pattern of pressure and swirl distortion. This flow distortion compromises the performance of the fan. By building complex computer simulations that include the inlet and fan stage as a coupled system, the research group can process and visualize high-fidelity computational results of inlet-fan interaction. Once the interaction effects are understood, future integrated designs will incorporate distortion tolerance and distortion reduction methods.

Graphic representation of a futuristic UAV autonomously prowling above a strategic location gathering intelligence.

Detail showing serpentine inlet and fan stage for a future UAV.



CFD visualization of serpentine inlet configuration. Colored lines represent streamlines of flow through the diffuser. The contour plane at the exit of the diffuser shows the distorted pressure field as it enters the turbofan engine.

IMPACTS:

- *The survivability and performance of future UAV systems*
- *Research and development collaboration with other contractors and manufactures*
- *The cost of modifying large expensive engine test facilities*

Michael G. List "AFRL Aerospace Systems Directorate", AFRL Wright-Patterson AFB, OH, investigator of this Challenge project which currently utilizes the AFRL DSRC HPC Systems Hawk and Raptor. This project has a total allocation of 1,500,000 hours on Hawk and 5,700,000 hours on Raptor. In addition, this project has performed many successful runs using HPC codes: FieldView, TURBO, and Star CCM.