Aeroacoustics

The development of civil supersonic aircraft capable of operating within the threshold of community noise regulations is continuing on different fronts. Wyle Laboratories, in collaboration with Penn State University and Eagle Aeronautics, has made significant strides in calculating sonic boom footprints from supersonic flight vehicles. Enhancements include sonic boom predictions over georeferenced terrain encompassing varying ground impedance, as well as distortions imposed by atmospheric turbulence.

Meanwhile, scientists at Stanford University, with support from NASA, are developing large eddy simulations (LES) capable of predicting the radiated sound from heated and unheated supersonic jets with complex geometries. Databases obtained at the small hot jet acoustic rig facility at NASA Glenn are being used to validate these models. Similar efforts at Boeing, under way since 2004, have demonstrated continued progress in the development and application of LES methodology. Accurate spectral predictions of jet noise, to within 2-3 dB over a meaningful range of frequencies, have been achieved from complex single-stream and dual-stream nozzle geometries and a wide range of jet operating conditions with the developed methodology.

Researchers at the University of Illinois at Urbana-Champaign are developing new theories for the dominant mechanisms responsible for the sources of core noise in aircraft engines. This effort is part of an NRA from NASA's subsonic fixed-wing program. The mechanism, often called "indirect combustion noise," is believed to be caused by thermodynamic interactions (entropy fluctuations) with the engine's turbine blades. Nonlinear simulations of the flow and acoustic radiation over an idealized turbine blade support the new theory.

Other activities in computational aeroacoustics and advanced measurement methods were sponsored this year by the Aeroacoustics Research Consortium. Managed by the Ohio Aerospace Institute, the consortium is a partnership among NASA Glenn, Boeing, General Electric Aircraft Engines, Honeywell International, Pratt & Whitney, and Rolls-Royce. Its programs include assessing the effectiveness of using phased microphone arrays to identify engine noise sources, the development of computational methods to predict high-speed jet noise, and the application of LES to acoustic liners.

The FAA sponsored an aircraft taxi noise study performed by Wyle Laboratories.

A collaboration between GKN Aerospace and Honeywell Aerospace brought continued progress in reducing engine fan noise. The two companies designed, fabricated, and tested a seamless double-layer engine inlet liner using a Hexcel HexWeb Acousti-Cap honeycomb core with a perforated composite facesheet. Far-field acoustic surveys on a full-scale demonstrator engine at Honeywell's Acoustic Test Facility demonstrated comparable results over a substantial range of engine speeds for the new design when compared to traditional liners. Testing also confirmed improvements in sound attenuation at high engine power settings using the seamless liners.

The counterrotating open fan engine architecture, successfully developed and flight tested by GE in the 1980s, is a candidate for the next generation of narrowbody aircraft. To meet community noise regulations, CFM International (a 50/50 joint partnership between GE and Snecma) has developed modern open rotor fan system designs using computational aeroacoustic prediction tools. Joint GE/NASA testing is scheduled to continue through early 2010 to demonstrate these concepts and validate the design tools.

In the area of space-based launch platforms, existing liftoff acoustic models used by NASA Marshall are being updated with new empirical data. One such set of experiments, conducted under a joint effort of NASA, Wyle Labs, and ATK Launch Systems, comprised three static firings incorporating more than 60 acoustic free-field microphones. The new acoustic models will be used to predict the liftoff acoustic environments of the Ares I and Ares V launch vehicles.

by **Charles E. Tinney**