Structural dynamics

Uninhabited aerial vehicles (UAVs) carrying munitions have made headlines this year. General Atomics Aeronautical Systems and the University of California, San Diego, performed flutter and in-flight launch simulations on the company's Predator UAV modified to carry Navy-developed mini-UAVs under its wings. The mini-UAVs were successfully launched during flight to perform missions independent of the host aircraft.

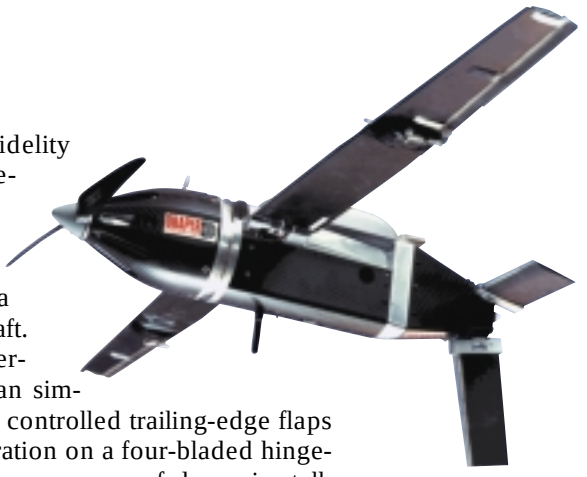
Draper Lab developed the Wide Area Surveillance Projectile UAV to fit inside a 155-mm artillery shell. Structural analyses and gun tests showed a high-strength enclosure could protect the folded aircraft from a 12,000-*g* environment. MIT and the University of Michigan investigated wing warping for roll control (the environment precludes ailerons). Both piezocomposite and NiTiNOL actuators were shown to be feasible.

In computational developments, the University of Texas, Austin, wrote a software implementation of the Automated Multi Level Substructuring eigenanalysis and frequency response analysis method. Reduced computing time means workstations now perform analyses previously requiring supercomputers.

Similar savings have been shown for reduced-order aeroelastic models using nonlinear Volterra series system identification models. This new method couples a single nonlinear database for a given configuration and Mach number with simulation software for graphic response display providing rapid determination of flutter onset for a given configuration and Mach number. Traditional methods couple a structural solver directly to a CFD solver, requiring more computation because each time step requires a CFD solution and each flight condition requires separate time-marching simulations.

CFDRC engineers with the Air Force Research Laboratory (AFRL) and NASA-Langley developed a method to analyze active smart material to alleviate vertical tail buffeting at high angles of attack. Finite-element models of piezoelectric actuators were integrated into a computing environment using Navier-Stokes for aerodynamics and nonlinear finite-element structural dynamics, facilitating the development of buffet alleviation systems for operational aircraft. For the first time, a high-fidelity fluid-structure-control interaction analysis was conducted over a full-scale aircraft.

The University of Michigan simulated actively controlled trailing-edge flaps alleviating vibration on a four-bladed hingeless rotor in the presence of dynamic stall. The simulation combines ONERA's dynamic stall model with a compressible time-domain unsteady aerodynamic model for the blade/flap configuration in attached flow and a free wake for variable inflow calculation.



Draper Laboratory's Wide Area Surveillance Projectile can deploy itself after being stored within a fired 155-mm artillery round.

As part of the NASA/Army/MIT/University of Michigan Active Twist Rotor Program, the first closed-loop forward-flight tests of active blades were successfully conducted at Langley's Transonic Dynamics Tunnel (TDT). Embedded active-fiber composites actively twisted blades of the 2.74-m-diam four-blade Mach/Froude scaled rotor. Controllers were successful in reducing vibration and improving rotor performance. An Army/NASA/Bell cooperative effort also tested a semiarticulated soft-inplane rotor hub in the TDT, a candidate for Bell Helicopter's Quad Tiltrotor program.

The Boeing Dragonfly demonstrator, a canard rotor wing aircraft capable of converting from rotary to fixed-wing operation, successfully completed ground vibration testing, structural mode testing, and hardware-in-the-loop simulation. Fully integrated rotor and propulsion system operation will be completed this year.

AFRL developed a unique traveling-wave excitation system for its Turbine Engine Fatigue Facility. The system simulates engine order excitation in stationary bladed disks to identify forced response localization and amplification due to mistuning. Capable of testing disks of various sizes, the system uses unique circuitry to reduce signal-generation costs. It was demonstrated on an 18-blade disk.

Boeing and Virginia Tech designed and tested a distributed vibration absorber device to reduce vibration in composite cylinders to reduce acoustic levels within launch vehicle fairings. An optimized absorber resulted in vibration reduction at the targeted modes by 18 dB. An active version was developed and tested for aircraft interior noise reduction. ⩓

by **Donald L. Edberg**