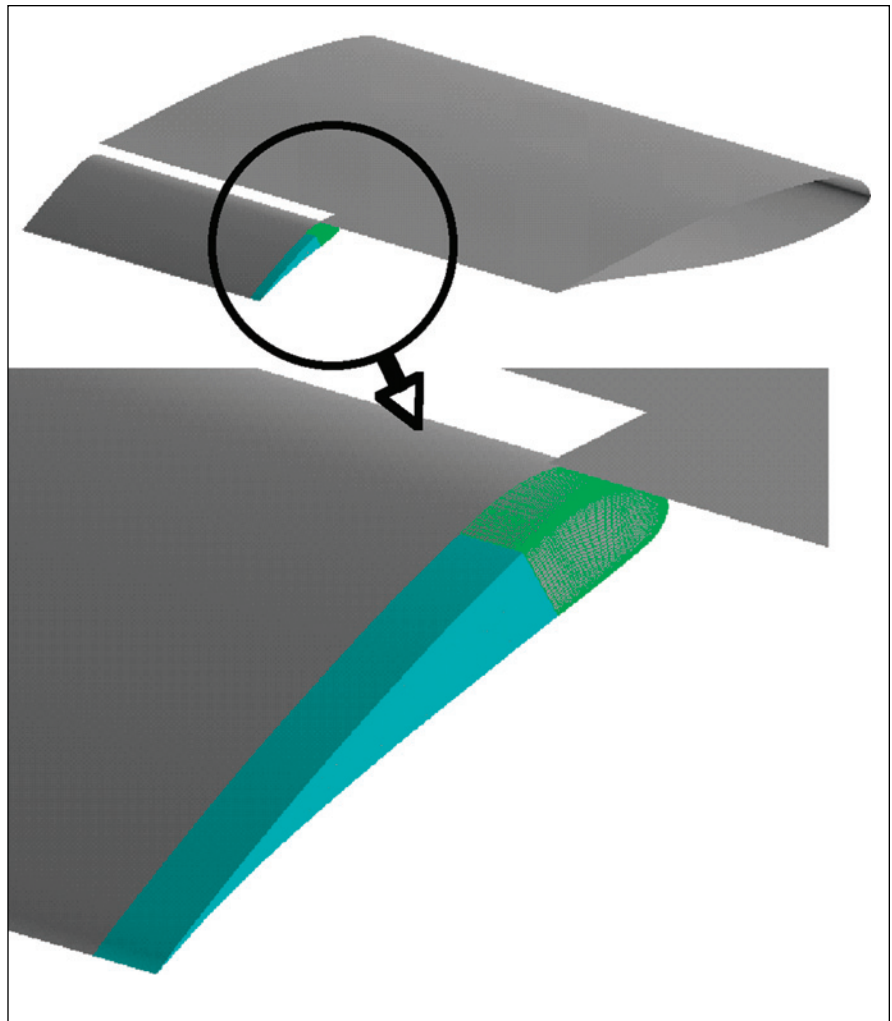


consist of free shear layers, the roll-up of these layers to form multiple vortices, merging of vortices, and, at high flap deflections, breakdown of these vortices. Because of their unsteadiness and their proximity to flap side-edge surface, these features can contribute to the noise radiated from the flap side edges. To be effective, any treatment for reducing the flap side-edge noise must eliminate, reduce, or alter the vortex initiation regime and the intensity of the vortex roll up and/or breakdown process near the side edge of the flap.

According to the proposal, small, carefully selected areas in the flap-tip regions of each flap would be rendered porous by use of materials similar to those used for wall cooling of turbine blades or the materials used towards acoustical treatment of aircraft-engine ducts (see figure). Porosity at the tips would provide a means of communication between the flow over the lower, side, and upper surfaces near the edge of the flap and, hence, modify the vortex structures near the tip.

Unlike side-edge fences that have been investigated for reduction of flap side-edge noise, the proposed treatment would not incur extra weight and is not likely to accrue drag penalty during the cruise phase of the flight. Unlike the porous tip treatments considered previously in a cut-and-try approach, the proposed porous tip treatment is based on comprehensive analysis of the acoustically relevant features of the flow field and, consequently, would be amenable to optimization. The airflow around the side edges of the flaps can be simulated using computational fluid dynamics (CFD), and results of CFD simulations can be combined with simplified math-



Model Geometry and Schematic of Treated Surfaces are shown. The cyan region depicts the aft-only configuration; the green mesh shows the additional area included in the leading-edge configurations.

ematical models of candidate porous treatments to analyze the effectiveness of the treatment in a specific application. Minimization of the amount of area that must be treated in order to reduce the flap side-edge noise to an ac-

ceptable degree could be an integral part of the design optimization process.

This work was done by Meelan M. Choudhari and Mehdi R. Khorrami of Langley Research Center. Further information is contained in a TSP (see page 1). LAR-16302-1

⚙️ Cylindrical Piezoelectric Fiber Composite Actuators

Cylindrical actuators offer advantages over flat flexible actuators.

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The use of piezoelectric devices has become widespread since Pierre and Jacques Curie discovered the piezoelectric effect in 1880. Examples of current applications of piezoelectric devices include ultrasonic transducers, micro-positioning devices, buzzers, strain sensors, and clocks. The invention of such lightweight, relatively inexpensive piezoceramic-fiber-composite actuators as

macro fiber composite (MFC) actuators has made it possible to obtain strains and displacements greater than those that could be generated by prior actuators based on monolithic piezoceramic sheet materials. MFC actuators are flat, flexible actuators designed for bonding to structures to apply or detect strains. Bonding multiple layers of MFC actuators together could increase force capa-

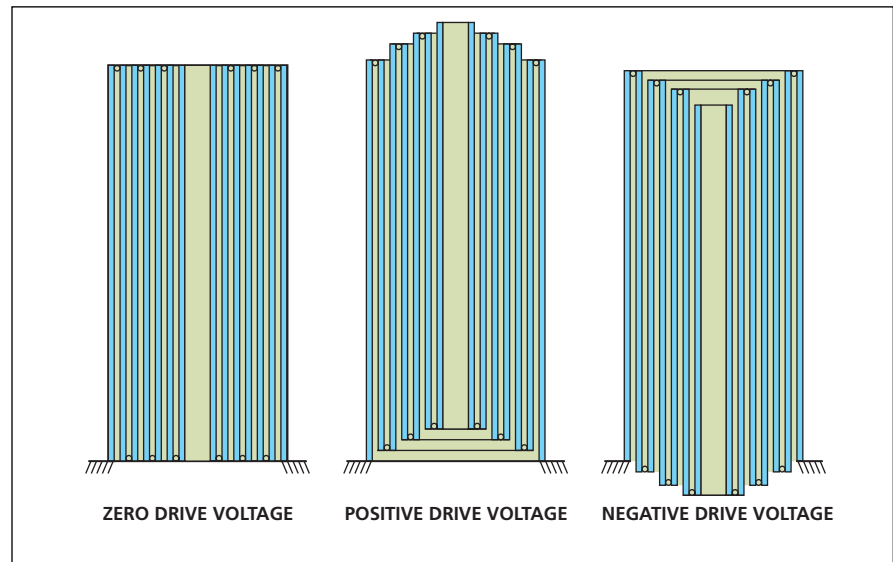
bility, but not strain or displacement capability.

Cylindrical piezoelectric fiber composite (CPFC) actuators have been invented as alternatives to MFC actuators for applications in which greater forces and/or strains or displacements may be required. In essence, a CPFC actuator is an MFC or other piezoceramic fiber composite actuator fabricated in a cylindrical instead of

its conventional flat shape. “Cylindrical” is used here in the general sense, encompassing shapes that can have circular, elliptical, rectangular or other cross-sectional shapes in the planes perpendicular to their longitudinal axes. CPFC actuators retain the desirable high strain or displacement and multiple-layer force enhancement capabilities of conventional flat piezoceramic fiber composite actuators. An advantage of the cylindrical over the flexible flat actuators is that the cylindrical shapes impart stiffness, so that unlike the flat actuators, the cylindrical actuators can bear loads even when they are not attached to supporting structures.

Another advantage of the cylindrical over the flexible flat actuators is that displacements of multiple CPFC actuators can be added together. For this purpose, CPFC actuators having different diameters can be assembled in a concentric telescoping arrangement and joined at alternating ends, as shown in the figure. Application of positive drive voltage causes the assembly to elongate in one direction; application of a negative drive voltage causes the assembly to elongate in the opposite direction.

CPFC actuators were first conceived as an improved means of strain-tuning optical-fiber Bragg gratings for applications involving tunable lasers. The ability to add the displacements of multiple self-stiffening CPFC actuators affords greatly enhanced strain-tuning range while still mak-



CPFC Actuators in a concentric telescoping arrangement are depicted here in meridional cross sections under three different drive-voltage conditions to illustrate how displacements are added.

ing it possible for strain-tuning assemblies to be compact and lightweight. However, CPFC actuators have potential utility in a broad range of applications beyond those involving tunable lasers. For example, CPFC actuator assemblies might supplant piezoelectric stacks in some applications, particularly those in which lighter weight and enhanced displacement are desirable.

In comparison with CPFC actuators, piezoelectric stacks are heavier and produce much smaller displacements. Displacements produced by piezoelectric

stacks can be amplified mechanically, but the mechanisms needed to effect amplification have considerable weight. Other actuators capable of larger displacements include hydraulic or gas piston-cylinder actuators, which are heavier and must be accompanied by supplies of pressurized hydraulic fluids or gases.

This work was done by Sidney G. Allison, Qamar A. Shams and Robert L. Fox of Langley Research Center. For further information, contact the Langley Innovative Partnerships Office at (757) 864-4015. LAR-17168-1