Modification of flow structures associated with trailing edge noise

On behalf of Dr. Richard Wlezien,
Meet our graduate candidate:

Hephzibah Clemons
Aerospace Engineering PhD Candidate
Iowa State University

Wednesday, July 15, 2015 // 9:00 a.m. //Rm 1235 Howe Hall

*** Trailing edge (TE) noise due to the interaction between a turbulent boundary layer (TBL) and an airfoil trailing edge is a major source of airfoil self-noise. This noise source generates sound from a few 100 Hz to the KHz range (~15,000Hz) and has a unique cardioid shaped directivity. Wind turbine blades and other subsonic airfoils generate significant TE noise. Improvements such as serrations added to the TE have shown to decrease the far-field noise generated without compromising the aerodynamic performance. A number of aeroacoustic TE noise theories have long been used as the basis for noise-reduction mechanisms. It is well known that they over-predict noise generation and reduction. Serrated trailing edges with different geometries are also known to decrease noise in certain frequency ranges and increase noise in others. In light of these discrepancies, recent work has been focused on trying to understand the flow mechanisms that cause noise and, by extension, the mechanisms that reduce noise.

In the present research, a NACA 0012 airfoil at a Reynolds number of ~850,000 and Mach number of 0.1 was chosen as a baseline configuration for the study of flow mechanisms near the TE. Several different configurations of the airfoil including blunt, sharp TE and zero and five degrees angle of attack were used as the baseline. Hot-wire anemometry with two traversing hotwires were used as the main sensor for unsteady velocity measurements. Span-wise and stream-wise correlations were obtained at different regions in the TBL near the TE to characterize flow structures. From these data, two regions having convective and absolute instabilities were isolated in the TBL. A serrated TE modification with dimensions scaled to the TBL at the TE was chosen as a flow modifier. Preliminary correlation and BL data in the two previously isolated regions show changes noticed in these regions as a result of the added serrations. Ongoing work is focused on more detailed study of these changes using other TE modifications and their potential contribution to TE noise and noise reduction.