MAE

Engineering Leadership

LECTURE SERIES

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101 DAVIS HALL

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PHYSIOLOGICALLY-INSPIRED PULSATILE FLOW OVER A SURFACE PROTUBERANCE

ABSTRACT

Our research is motivated by human speech production, or phonation. Speech production involves unsteady pulsatile flow and turbulent structures that affect the aeroacoustics and fluid-tissue interaction. Our overarching motivation for studying flow associated with phonation is to facilitate evaluation and design of treatment interventions and for surgical planning, i.e. to enable physicians to assess the outcomes of surgical procedures by using faithful computer simulations. We also seek to inform non-surgical clinical treatment strategies of voice disorders. Silicone-based, self-oscillating synthetic vocal fold (VF) models are fabricated with material properties representative of the different layers of human VFs and then evaluated experimentally in a life-size in vitro vocal tract simulator to replicate physiological conditions. Our experimental investigations utilize high-speed imaging, particle image velocimetry (PIV), pressure transducers and microphones, and the clinical Rothenberg mask. Studies are performed under both normal and pathological conditions of speech.

Our recent attention has been focused on understanding the role of polyps (growths on the VF) in altering voice quality. This has led to fundamental studies of 3D flow separation around surface mounted obstacles in pulsatile flows. We have generalized our studies to various surface protuberances – hemispheres, cubes and cylinders immersed in highly pulsatile flow. In addition to experiments we have performed CFD simulations using an in-house Navier-Stokes code. These investigations are designed to unify the classical instantaneous description of shed hairpin vortices with the standing arch vortex viewpoint that arises from phase averaging.

BIO SKETCH

Dr. Michael W. Plesniak is Professor and Chair of the Department of Mechanical & Aerospace Engineering at the George Washington University, with a secondary appointment in the Department of Biomedical Engineering. Prof. Plesniak is the Director of GW's Center for Biomimetics and Bioinspired Engineering. He was formerly Professor of Mechanical Engineering at Purdue University and Eugene Kleiner Professor for Innovation in Mechanical Engineering at Polytechnic University in Brooklyn, NY. He served as the Director of the Fluid Dynamics & Hydraulics program at the National Science Foundation from 2002-2006. Prof. Plesniak earned his Ph.D. degree from Stanford University, and his M.S. and B.S degrees from the Illinois Institute of Technology; all in Mechanical Engineering. Dr. Plesniak is a Fellow of AIAA, ASME, the American Physical Society (APS), the American Institute for Medical and Biological Engineering (AIMBE) and the Association for the Advancement of Science (AAAS). He has authored over two hundred fifty refereed archival publications, conference papers and presentations, and has presented numerous invited seminars and keynote addresses. His research group is currently studying the pulsatile flows, physics of phonation, cardiovascular flows and tissue engineering. Prof. Plesniak was a recipient of the 2018 Washington Academy of Sciences Distinguished Career in Engineering Award, 2017 ASME Fluids Engineering Award, and the 2011 NASA DC Space Grant Consortium's Outstanding STEM Faculty Award, awarded to faculty that make an outstanding contribution to STEM that goes above and beyond the classroom. Dr. Plesniak was also named the American Institute for Aeronautics and Astronautics, National Capital Section Engineer of the Year 2010-2011.

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