Rigid-Body Shape-Changing Mechanisms

Dr. Andrew Murray

Abstract: A variety of machine design problems are specified by a set of curves defining a useful change in shape. Consider the camber of a wing or automobile spoiler and the advantages that are gained when that camber is capable of change while in use. For the spoiler, creating additional downward force during cornering could be desirable. For the wing, as the fuel load lightens less lift is needed and is desirable because of the reduced drag. This talk will present the underlying theory of shape-change and show several examples. The theory will address the appropriate handling of the design curves in order to identify useful part geometries. Two significant examples include variable geometry dies for polymer extrusion and morphometry. Extrusion is used to make a host of parts, from PVC tubing to weather stripping to artificial lumber for decking. Extrusion is valued because it is inexpensive and fast when compared to molding, the other primary way of making plastic parts. Extrusion has been limited by the requirement that it be a constant cross-section. Variable-geometry dies are not subject to this requirement and allow the cross-section to vary during the extrusion process. Morphometry, the second significant example, is the quantification of change in shape and is frequently used to study changes due to evolution and growth, an application outside of engineering. Shape-change is applied to the morphometry of cochlea and growing skulls, viewing the changes as potentially described via analogies to mechanical systems. Finally, many of these ideas have been extended to curves in three dimensions.

Bio: Andrew Murray received the B.S. degree in mechanical engineering from the Rose-Hulman Institute of Technology in 1989, and the M.S. and Ph.D. degrees in mechanical engineering from the University of California, Irvine in 1993 and 1996, respectively. In 1997, he joined the Department of Mechanical & Aerospace Engineering at the University of Dayton as an Assistant Professor, became an Associate Professor in 2003, and a Professor in 2011. He Directs the Design of Innovative Machines Lab (DIMLab) where the research in kinematic synthesis theory and machine design includes shape-changing mechanisms with applications in variable geometry extrusion dies, novel devices that utilize strain-energy in automobiles, and accurate estimation and tracking of the center of mass of complex systems. He also has a long-standing collaboration with researchers at the Laboratoire d'Informatique, de Robotique et de Microélectronique in Montpellier, France. Dr. Murray is a Fellow of ASME. He won the highest teaching award offered by the University of Dayton in 2013. He was General Program Chair of the ASME International Design Engineering Technical Conferences in 2010 and is serving a fourth term as an Associate Editor for the ASME Journal of Mechanisms and Robotics. Please visit sites.udayton.edu/DIMLab to learn more about the research and the DIMLab.