Abstract Submitted
for the DFD13 Meeting of
The American Physical Society

Flow Structure on a Wing Due to Unsteady Pitch-Up and Rotation Maneuvers MATTHEW BROSS, TURGUT YILMAZ, DONALD ROCKWELL, Lehigh University — The flow structure along a rectangular (low aspect ratio) wing undergoing pure pitch-up, pitch-up with rotation, and pure rotation is characterized as a function of dimensionless convective time τ during each maneuver. Quantitative imaging via angular displacement stereo particle image velocimetry was used to determine the three-dimensional velocity field, thereby allowing analysis of the effects of different wing kinematics via representations of Q-criterion, vorticity flux, and velocity and vorticity contours. Despite the difference in wing kinematics, interactions between leading-edge and tip vortices persist across all values of τ. The three-dimensional flow structure involves a symmetric pattern along the wing during pure pitch-up and transforms to a conical leading-edge vortex in conjunction with a tip vortex that extends into the wake for both pitch-up with rotation and pure rotation. This observation suggests that rotational motion has a greater influence than pitching motion in establishing the form and scale of the leading-edge vortex. Finally, sectional images of the flow structure arising from combined pitch-up and rotation were acquired at three different pitch rates relative to a given rate of pure rotation at fixed angle of attack.

Matthew Bross
Lehigh University

Date submitted: 29 Jul 2013 Electronic form version 1.4