

Abstract Submitted
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The Drag Penalty of Lateral Asymmetries in Formation Flight¹

DANIEL WEIHS², KAREN GABBAY, Faculty of Aerospace Engineering, Technion, Haifa — It has long been known that formation flight of birds and aircraft results in a significant energy saving due to reduction in induced drag. However measured gains have consistently been lower, usually explained by viscous effects neglected by the potential flow model for lift and induced drag. We show that the inherent asymmetry of the flow-field in the general case results in rolling and yawing moments, which need to be corrected by control surface deflection. This deflection results in an increase in drag, which partially cancels the gains mentioned above. Using classical lifting line theory and elliptical lift distributions on two or more wings flying in formation we show that the penalty incurred by these corrections can reduce the expected gains by up to 25%. We also show that the gains for an individual in formation flight grow with the number of members of the formation, up to about 7 members, the added gains becoming negligible beyond that number. The present results are relevant for large aspect-ratio, fixed wing aircraft, and gliding bird flocks.

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