Determining Wing Performance from Measurements in the Turbulent Self-Preserved Wake

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**ABSTRACT:** The self-preserved turbulent wake behind an airfoil is explored to determine whether wing performance information can be extracted. The turbulent wake 10 chord lengths downstream of an SD7003 wall to wall airfoil model is analyzed through the lens of the irreversibilities in the flow. The concept of exergy is used to quantify these irreversibilities. A theoretical approach is presented wherein the drag coefficient can be used to estimate either a Reynolds Stress distribution or [indirectly] a model of the profile of the mean streamwise velocity component of the turbulent wake. The variation in the [surrogate] eddy viscosity obtained from an empirical factor in this model is then incorporated into the model for the exergy destruction rate in the turbulent wake. To validate these models, the velocity field experimentally obtained by Particle Image Velocimetry in the wake of a wall-to-wall SD7003 airfoil is used to calculate the exergy destruction rate through the finite difference technique. The results from the exergy destruction rate model are validated against the exergy destruction rate obtained from experimental data and they show good agreement. Most remarkable, however, is that changes in integrated wing performance can be extracted from changes in the stratified turbulent wake 10 chord lengths downstream of the wing.

**Bio:** At the age of 11, Aaron apprenticed at an automobile engine rebuilding shop where he worked for 11 years. Aaron received his bachelor’s degree in Mechanical Engineering with a second major in Applied Mathematics from Tulane University in New Orleans. He then moved to the University of Texas at Austin where he received a Master’s degree in Mechanical Engineering with a focus on aerodynamics. After finishing a PhD in aerospace vehicle design at Cranfield University in the UK, Aaron moved to Toulouse, France to work for Airbus France where he worked on the Airbus A340-600 and A380. He came to the University of Dayton in the Fall of 2002 where he is in charge of the Aerospace Engineering graduate program. Since his arrival in Dayton Aaron has worked approximately half of his time in situ at Wright-Patterson Air Force Base in the US Air Force Research Labs (mostly in the SARL, TGF and Vertical wind tunnels). His focus is experimental investigation of Vortex Formation and Shedding, Morphing Wing Air Vehicles, Airfoil/Wing/Configuration Aerodynamics, Aircraft Turbulent Wakes, High Angle of Attack Aerodynamics, Low speed/Low Reynolds Number Aerodynamics, Micro Air Vehicles, Propeller Aerodynamics, Unsteady Aerodynamics, Flapping Wing Aerodynamics, Wind Tunnel Aerodynamic Testing, Wind Turbine Aerodynamics, Road Vehicle Aerodynamics, and Conceptual Aircraft Design.

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