UNIVERSITY OF NOTRE DAME
Department of Aerospace and Mechanical Engineering
AE 440: Flight Mechanics and Introduction to Design
Fall 1998

Project #10
Due: Friday, October 30, 1998

Continuing in our efforts to improve the "tools" used for aerodynamic modeling and design, we have recently adapted a vortex lattice technique for use in conceptual and preliminary design studies. This code referred to as UNDVLM, is based on a code developed by NASA in the mid 70's but since "potential flow" hasn't changed too much since then, the code is still a valuable preliminary design tool. Most of the adaptations have been intended to streamline input data preparation and output data presentation. Like all engineering software, your success in using it will depend upon your basic understanding of the assumptions and limitations associated with the analysis methods used. You have seen all of the techniques invoked in this software in earlier courses and now we would like to use this "engineering tool" to assist in concept design. You will be provided a "User's Manual" for UNDVLM which will describe a number of issues related to its development and use. Once you have familiarized yourself with the code we would like to continue in the development of the UAV which we used in the previous project.

Our limited database implies that aircraft in this class have very low wing loadings of approximately 1 lb/ft^2 and horizontal tail volume coefficients of 0.5 - 0.7. Lifting surface structures for this class of very lightweight aircraft weigh approximately 0.09 lb/ft^2.

1. Using the airfoil you selected in the previous project, you now wish to determine a wing planform and size the horizontal stabilizer (or canard!) Select and size a baseline rectangular wing planform, rectangular horizontal stabilizer and their relative locations on the fuselage using the database information provided above and your "intuition". Sketch to scale an "initial configuration" assuming a 48" long fuselage with a 7"x7" square cross section fuselage. For a number of reasons the propulsion system is placed at the front of the fuselage which weights approximately 10 lbs (fully loaded).

2. Using the baseline wing-alone planform and the airfoil you selected in the previous project, estimate the aircraft C_{Lmax} using UNDVLM for the clean wing configuration and compare this result with your required C_{Lmax}.

3. Conduct a parametric trade study to determine the sensitivity of your design to changes in aspect ratio and taper ratio. You can select whatever measures of merit and constraints you wish to use in this study but be careful to describe and justify each.

4. Using the results of your trade study select a "revised" configuration for your design and "redraw" your aircraft concept attempting to locate the aerodynamic center of the wing at the aircraft c.g.. Changes in the wing may require you to resize your horizontal stabilizer. Develop the the pitching moment curve for the "wing/tail" model of your aircraft about the aircraft c.g. and evaluate the current status of the design.