1994023409

N94-27912

Experimental Apparatus for Optimization of Flap Position for a Three-Element Airfoil Model

by

Professor Drew Landman
Department of Engineering Technology
Old Dominion University
Norfolk, VA 23529

Abstract: It is proposed to design and build a wind tunnel model comprising a Douglas Aircraft Company three-element high-lift airfoil with internal actuators to move the flap vertically and horizontally under computer control. The model will be used to find the optimum flap location for a fixed angle of attack, slat position and flap deflection angle. The model will span the full tunnel width and lift will be measured by integration of pressure readings taken from midspan taps. It is proposed to conduct experiments in the NASA Langley EFPB 2' x 3' low speed wind tunnel. This report serves as a project overview and a review of work completed to date through funding by the 1993 NASA/ASEE Summer Faculty Fellowship Program.

Introduction: The impetus for this project stems from advances in high lift system design coupled with an increasing interest in wind tunnel productivity. A large part of the time currently spent during wind tunnel testing is due to model configuration changes. The elimination of a significant portion of this time would allow more time for experimentation. Further, if model geometry could be changed during a run, new procedures for seeking the optimum geometry may be possible.

One of the long term goals of this project is to extend the technology developed to the NASA Langley Low Turbulence Pressure Tunnel (LTPT), used for higher Reynolds number testing. The remote actuation concept is particularly inviting in a pressurized tunnel since the pressurization cycle time between configuration changes can be eliminated.

It is hoped that a better understanding of the flow physics of a 3 element high lift system will be gained through experimentation with a matrix of flap gap and overhang values. The model can be set for a fixed angle of attack and flap deflection angle, and then a great quantity of data can be generated quickly and automatically.

Project Outline: The project requires work in the following areas: mechanical design, wind tunnel instrumentation, computer control, optimization, fluid mechanics, and high lift aerodynamics. This multidisciplinary requirement provides a natural progression towards the goal of a working wind tunnel model.

The first step is to design the mechanical system that will actuate the flap. This first phase was completed this summer. The system was designed to move the flap through a working range of gap and overhang values. Deflection under load was calculated and minimized for maximum positional accuracy. Actuators were located inside the model and external brackets made as slender as possible and streamlined to provide minimum obstruction to flow. At the present time an actuator stage is being constructed for testing.

After the mechanical design specifications have been met, the computer control system can be assembled. It is proposed to use DC gearmotors to move the flap brackets. Control will be through a standard interface in a PC or a Sun workstation. This setup will facilitate the easy interface of existing data acquisition software (LABVIEW) and hardware, with model geometry control.

With control in place, optimization is the next goal. Operational and optimization procedures will have to be developed. When a procedure is established, interfacing custom programs with the data acquisition software (LABVIEW) and the motor control software (source in BASIC, C etc.) will make it possible to optimize the flap position. Optimum might be taken to imply maximum lift coefficient, maximum L/D, minimum drag etc., depending on the requirements imposed.

Finally, a detailed study of the flow physics will be conducted for the optimized position. Results should be correlated with data expected from a fixed model and CFD results. It is hoped that this analysis, and indeed the new test method and procedure, will lead to a better understanding of high lift aerodynamics.

List of Figures:

Figure 1

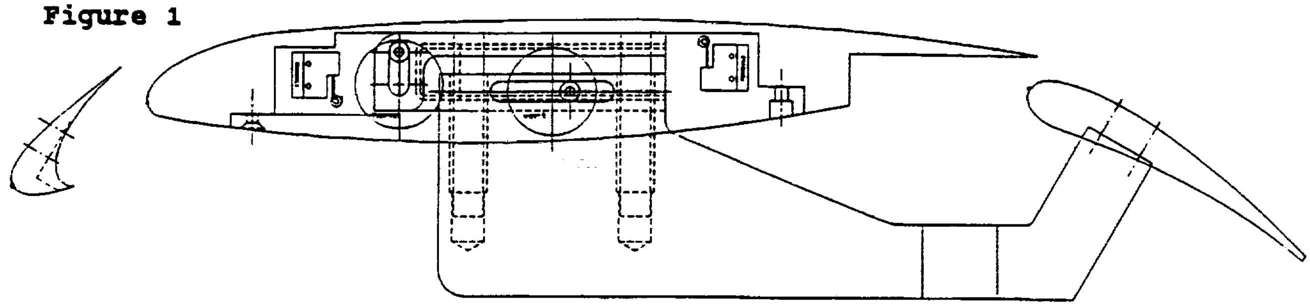

Figure 2

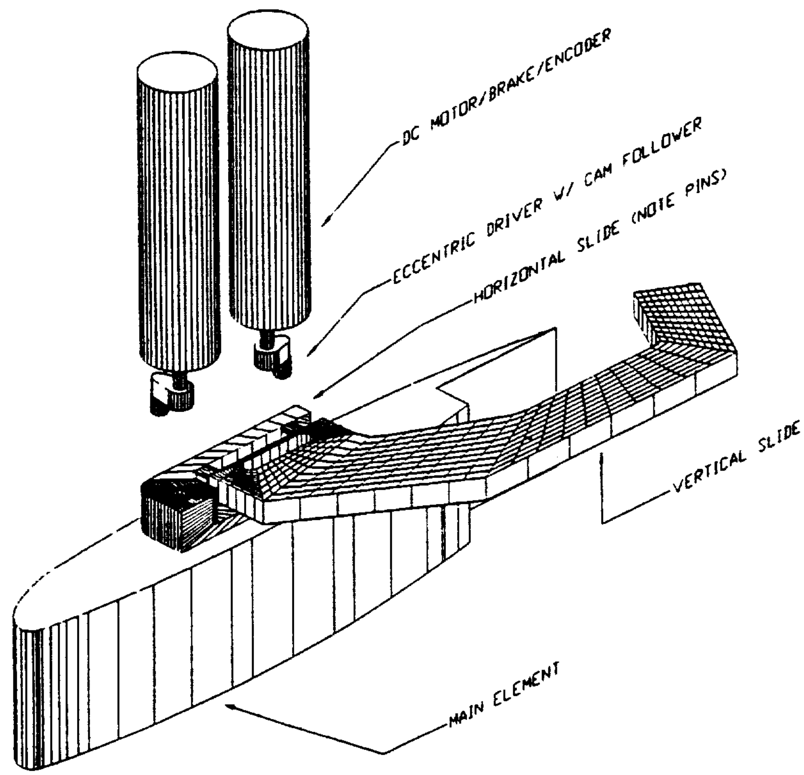

Figure 3