

SOME NEW AIRFOILS

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SUMMARY

A computer approach to the design and analysis of airfoils and some common problems concerning laminar separation bubbles at different lift coefficients are discussed briefly. Examples of application to ultralight airplanes, canards, and sailplanes with flaps are given.

INTRODUCTION

In the 1940's, NACA demonstrated clearly that it is possible to design airfoils from pressure distributions in such a way that the boundary layer would behave in a desired manner (Refs. 1 and 2). At that time, it was discovered that the boundary layer would remain laminar longer if the pressure minimum occurred further aft on the airfoil. This realization led to the first laminar airfoils. Since that time, better methods for designing airfoils from pressure distributions have been developed (Ref. 3). Simple methods for computing the characteristics of laminar and turbulent boundary layers including a feasible transition criterion have also been developed (Ref. 4). The occurrence of laminar separation bubbles has been detected and studied experimentally (Ref. 5) and correlated with theory (Ref. 4). Good methods for the analysis of the potential flow around a given airfoil have been developed (Ref. 6). Thus, it was possible to write computer programs which combine all these methods. These programs allow airfoils to be designed with prescribed pressure-distribution properties, the boundary-layer characteristics to be determined, and the effects of shape modifications such as plain or variable geometry flap deflections to be analyzed. A complete description of such a program system will soon be published as a NASA technical memorandum (Eppler and others). This system is somewhat equivalent to a wind tunnel. Three fundamental differences do exist, however. First, the computer analysis of an airfoil is much less expensive than the corresponding wind-tunnel test. Second, the total time required to obtain the final results is much shorter. Third, much more data, such as development of the boundary-layer shape factor and thickness, are available. Moreover, the modification of an airfoil through prescribing the pressure distribution, which must be done on the computer, is integrated into the program system. This allows a boundary-layer development with prescribed properties to be obtained directly.

Thus, the time has come to use the computer when a new airfoil is to be developed. Wind-tunnel and flight tests should be used to obtain a better