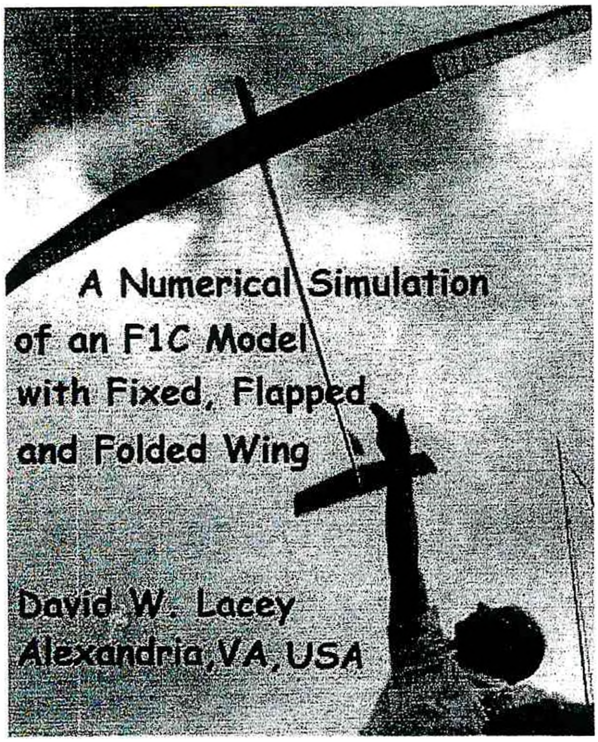
Сергей



Introduction

The International Free-flight class of gas models, F1C, is unique among the free-flight classes, in having no minimum aerodynamic surface area requirement. This lack of requirement has led to the F1C folder, a configuration which allows approximately the outer half of the wing to be folded under the inner half. This unique configuration has led to significant performance advantages. But how significant are these advantages? Flight measurements have been taken and clearly performance is increased. However, flight tests involve many variables which are often not consistent between test flights of the same model let alone comparisons between different configurations flown by different competitors.

A means of overcoming the difficulties is the numerical simulation. A numerical simulation can be thought of as an ideal flight test. Atmospheric conditions are constant, the motor is always running at the right rpm (i.e. power) and the launch angle and speed are the same for each flight. The prime advantage of numerical simulation is that it allows the variation of a single variable for a given run. The numerical simulation is dependent on data obtained from other sources such as wind tunnel tests, not the actual flying model. Thus reasonable care is required in choosing data to be used in the simulation. In this paper, a numerical simulation has been conducted using wind tunnel data taken at speeds and Reynolds Numbers representative of F1C flight conditions for the basic fixed wing, flapped wing, and folding wing model configurations. Investigated are the effects of drag, propeller efficiency, increases in power and propeller gearing, as well as launch speed.

The simulation indicated that the difference in altitude at motor cut-off is not significant for the three primary configurations. The rate of sink in glide favors the variable wing geometry (flaps, folding wing) significantly.

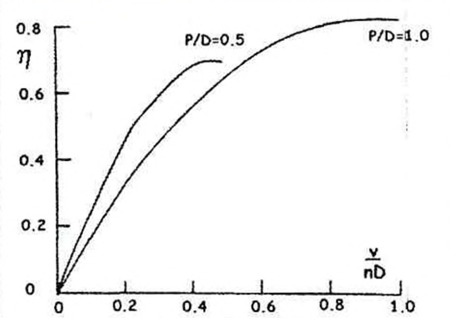


Fig. 1 Propeller efficiency

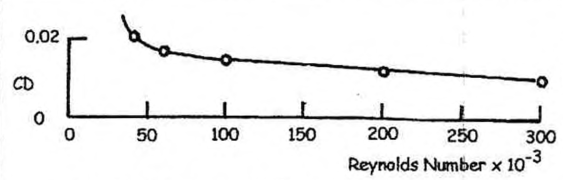


Fig. 2 CD at zero lift for MA-409 airfoil

Background

Flight of a high powered free-flight model consists of three phases: vertical flight, transition, and glide.

Vertical flight of a model is given by the following equations:

$$m\,a = thrust - drag - weight$$
$$a = acceleration;\; V = velocity$$
$$thrust = \frac{power}{V}\eta_P$$
$$\eta_P = propeller\ efficiency$$
$$Drag = C_D\, q_\infty\, S$$
$$q_\infty = \frac{1}{2}\rho V^2;\; \rho = air\ density$$
$$S = Wing\ Area$$

The engine characteristics were given by Gil Morris and are typical of present usage. These characteristics are: Power = 1 Hp. A 7D x 3P prop is used, rotating at 30,000 rpm static for direct drive. The geared propeller is 12.5D x 12P turning at 8,000 rpm static.

The best propeller data available is the data obtained by Durand, presented in NACA Report 237 (reference 1). These data are close in Reynolds Number to F1C propellers and will be used without correction. Durand tested propellers from P/D = .5 to P/D = 1.1. For purposes of this simulation the direct drive prop uses the Durand P/D = 0.5 data, and the geared prop uses P/D = 1.0. The propeller efficiency from the NACA Report for the two P/D's is shown in figure 1.

High performance gas models such as F1C's fly over a wide speed range. Climb speed can vary from 0 to close to 140 feet per second. Glide speed is approximately 20 feet per second. This range of high to low speed, approximately 7 to 1, puts the F1C in the same class as transonic fighter attack aircraft. This range in speed is also reflected in a similar large Reynolds range. The drag coefficient varies with Reynolds Number, and thus for simulation varying Drag coefficients must be used. A typical variation of C_D with Reynolds Number is presented in figure 2.