Experimental Wing and Canard Jet-Flap Aerodynamics

D.B. Smeltzer* and D.A. Durston†
NASA Ames Research Center, Moffett Field, California
and
V.R. Stewart‡
Rockwell International, Columbus, Ohio

Abstract

THE effects of upper surface blowing on the aerodynamics of a ½-span wing/body/canard configuration are shown. The results expand a data base that is limited at high subsonic Mach numbers (M=0.6-0.9), data that are needed if computational techniques are to be developed for the complex flowfields generated by jet blowing. At lift coefficients greater than about 1.0, the thrust removed drag coefficient was lower with jet blowing than without jet blowing. This favorable effect increased with increasing jet blowing coefficient, and, for a fixed coefficient, simultaneous wing/canard jet blowing was slightly more effective than blowing either surface alone.

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Upper surface blowing over a trailing edge flap has been shown to reduce drag due to lift at high angles of attack and at high subsonic Mach numbers.[1,2] Moreover, jet blowing increased the lift coefficient obtainable before the onset of

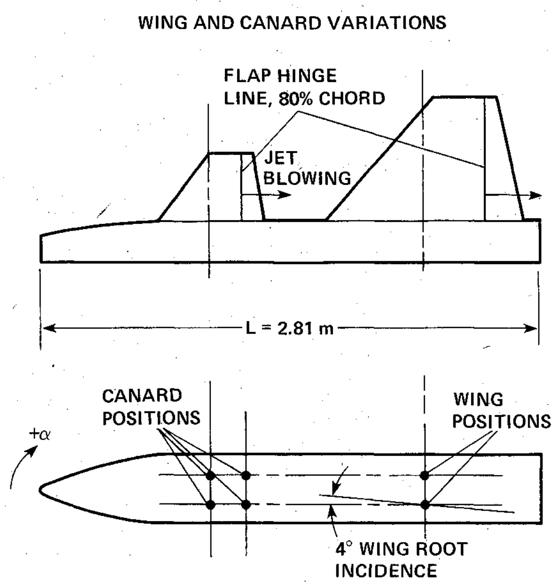

Fig. 1 Model details.

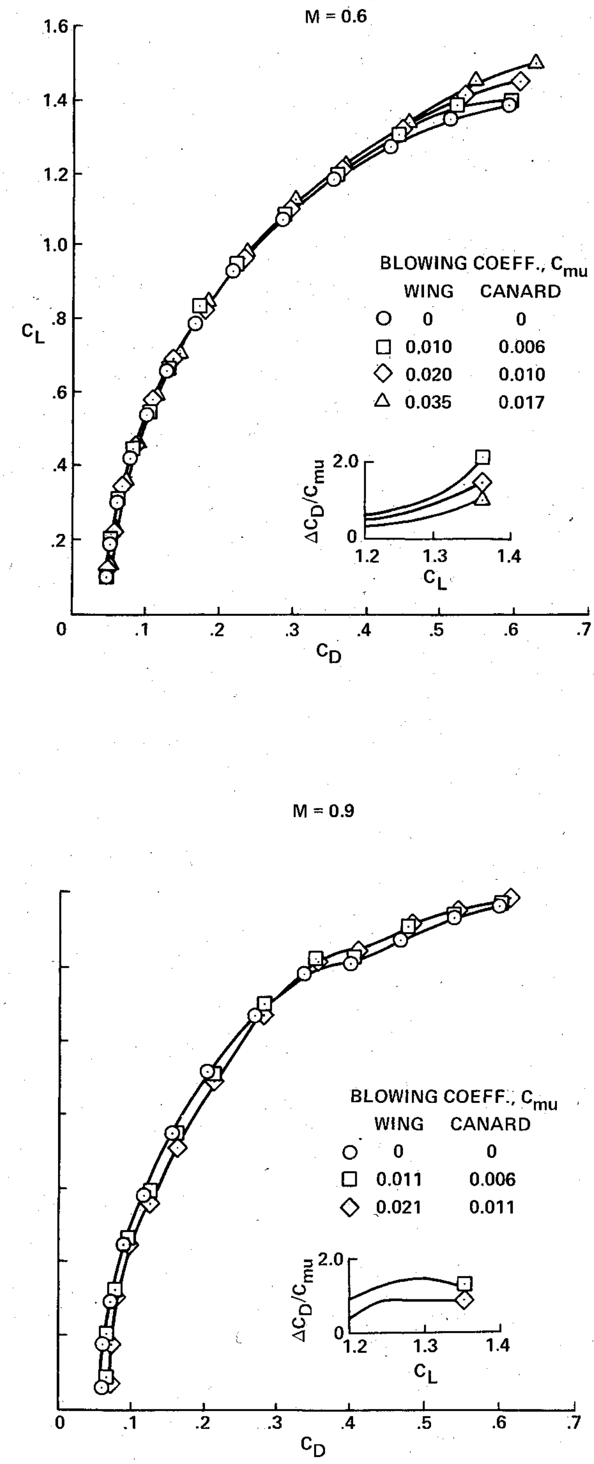

Fig. 2 Effect of blowing on lift and drag.

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*Aerospace Engineer.

†Aerospace Engineer. Member AIAA.

‡Aerospace Engineer, North American Aircraft Division. Member AIAA.

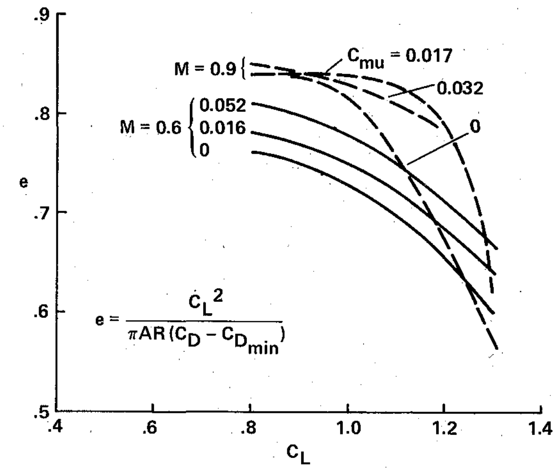

Fig. 3 Effect of blowing on the drag efficiency factor.

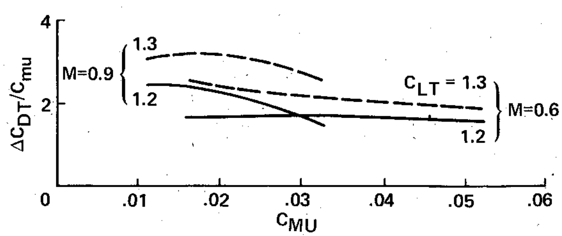

Fig. 4 Total lift and drag characteristics.

buffet.[1] The present investigation expanded this concept to a wing/body/canard configuration.

Wind tunnel tests were conducted at Mach numbers of from 0.6 to 0.9 and at angles of attack from −4 to 20 deg using the ½-span model shown in Fig. 1. The jet blowing mass flow was independently controlled to the wing and canard. Results herein are shown only for the low-wing high-forward canard configuration.

The effects of jet blowing on the static thrust removed lift and drag coefficients are shown in Fig. 2 for the best blowing arrangement, simultaneous wing/canard blowing. The drag polars were favorably affected at high C_L and unfavorably affected at low C_L. The crossover point was a C_L of about 1.0. Blowing is most efficient at the lower blowing rates; since at a constant C_L, the amplification factor $(\Delta C_D/C_{mu})$ increased with decreased blowing.

The drag efficiency factor based on the thrust removed values of C_L and C_D is shown in Fig. 3. This factor was unfavorably affected between the low and high blowing coefficients at $M=0.9$ and high C_L. Surface pressures at $M=0.9$ showed that a shock train was formed on the wing flap due to blowing, a possible cause of the loss in efficiency.

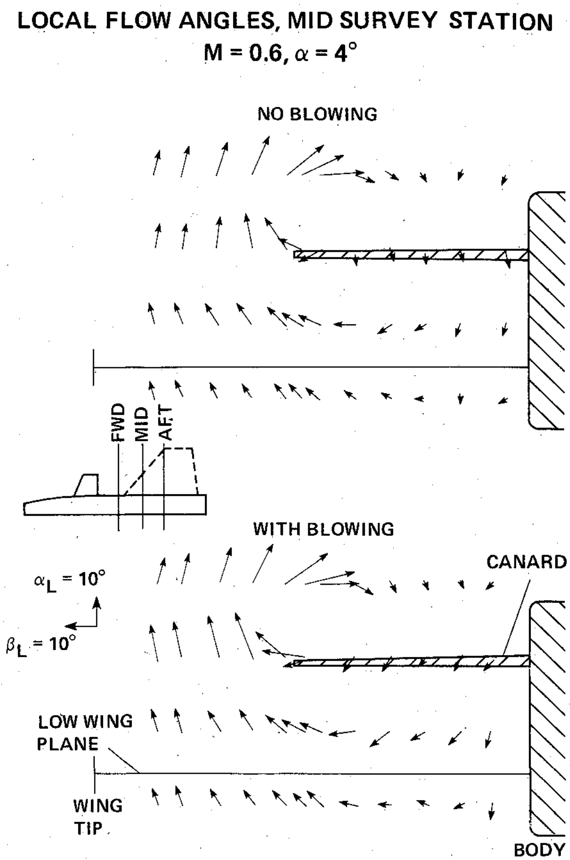

Fig. 5 Flowfield characteristics.

The effects of blowing on the total lift and drag characteristics, that is, with the static thrust not removed, are shown in Fig. 4. The drag minus thrust amplification factor $(\Delta C_{DT}/C_{mu})$ varied, as did the thrust removed amplification factor; it generally decreased with increased blowing and increased with increased C_{LT}.

Figure 5 shows the effect of blowing on the local angles of attack and sideslip in the flowfield; the local angles are relative to the body. Note that the wing was removed for these measurements. The flow angles are affected only slightly by blowing particularly in the plane of the wing.

References

[1]Woodrey, R.W., Whitten, R.D., Smith, C.W., and Bradley, R.G., "An Experimental Investigation of a Vectored-Engine-Over-Wing Powered Lift Concept. Vol. I. Low Speed Transonic Tests," AFFDL-TR-76-92, Sept. 1976.

[2]Oyler, T.E., "Investigation of Airfoil Characteristics at Transonic Speeds on a Supercritical Shape with Tangential Blowing," Rockwell International, Columbus, Ohio, Report NR75H-165, Jan. 1976.