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NASA TECH BRIEF

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Program Computes Zero Lift Wave Drag of Entire Aircraft

The problem:

To develop a program to compute zero lift wave drag of an entire aircraft including any combination of the following components: wing, body, pods, fins, and canard. Two optimal aims of the program are to compute the external volume of the wing and to compute the axial area distribution of the wing equivalent body.

The solution:

Since the rule was formulated, and verified experimentally, that the transonic wave drag of an aircraft is essentially the same as the wave drag of an equivalent body of revolution having the same cross-sectional area distribution as the aircraft, attempts have been made to estimate aircraft wave drag by examining the equivalent-body area distribution. It has been found that reasonably good wave-drag estimates can be made near Mach 1 if slender-body theory is applied to the aircraft area distribution. This procedure can be extended to higher speeds with good results by using the supersonic area rule to determine the equivalent-body area distributions.

How it's done:

A major problem in adapting this procedure to machine computation is that of describing a rather complex aircraft to the computer in sufficient detail. The location of all the aircraft components are referred to an X–Y–Z axis system with the origin at the nose of the fuselage. The variation in fuselage radius along the axis between stations is assumed to be linear. Pods are similarly described. The wing is described as a sequence of streamwise airfoils distributed along the span. The contour of the wing is assumed to be linear between successive ordinates. The horizontal and vertical tails are described in a manner similar to that of the wing.

Once the aircraft description has been stored in the memory unit of the computer, the equivalent-body area distributions are determined by solving for the normal projection of the areas intercepted by a family of cutting planes tangent to the Mach cone. In addition to the aircraft wave drag, the program lists the wave drag of the aircraft equivalent bodies at each Mach number as well as selected equivalent-body area distributions. This additional information is particularly useful in tailoring a configuration for minimum wave drag because, in order for a configuration to be optimized at some supersonic speed, it is necessary to examine the series of equivalent bodies corresponding to the particular Mach number. It should also be noted that the area distributions required in the computation of sonic-boom overpressures are provided.

Notes:

1. The program is written in Fortran IV for use on the IBM 7094 computer.
2. Inquiries concerning this program may be directed to:

   COSMIC
   Computer Center
   University of Georgia
   Athens, Georgia 30601
   Reference: B67-10530

Patent status:

No patent action is contemplated by NASA.

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Category 06

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