4.1 Roll Acceleration Approximation

For configurations featuring mid-fuselage mounted wings, no dihedral angle and at negligible angles of sideslip, roll acceleration may be expressed using:

$$(1) \quad \dot{P} = (q * S * b / I_{xx}) * Cl_{\delta a}$$

from Reference 5, roll inertia may approximated from Reference 6:

$$(2) \quad I_{xx} = (b^2 * W * R^2_x) / (4 * g),$$

in which R_x is a non-dimensional radius of gyration which may be approximated by a statistical average of data for aircraft of a similar type. Reference 6 contains data tables listing values of non-dimensional radii of gyration for a large number of aircraft, grouped according to type. For this study, $R_x = 0.235$ was used, being an average of six similar fighters between 16,000 and 37,000 pounds gross weight (71171 - 164583 N). Based on lambda wing planform test data, $Cl_{\delta a} = -.002$/deg was used as a representative value for aileron control power at the maneuver point condition.

Equations (1) and (2) can be combined to create an approximate expression for roll acceleration in terms of aspect ratio and span loading:

$$(3) \quad \dot{P} = -1164 / (AR * (W/b))$$
$$\text{SI units} = -118.7 / (AR * (W/b))$$

This expression, to a first order estimate, accounts for small changes in vehicle geometry and weight on roll inertia and acceleration, respectively. Accuracy is restricted by physical similarities with database aircraft, including weight, geometry and control surface layout.

Roll acceleration was calculated using (3) for CASP sizing results at a given wing loading, thrust loading and aspect ratio combination.

5. Trade Study Configuration

Figures 5 and 6 present the general arrangement of the trade study configuration used. For sizing studies, wing planform, fuselage and tail geometry were held constant. Wing area, aspect ratio and longitudinal position were varied.

The wing planform used is a generic "lambda" planform, so named for its resemblance to the greek letter λ. This type of shape is convenient for aspect ratio and sizing manipulations, as well as volumetrically effective for internal storage of fuel, weapons or landing gear. Planform test data from Reference 7 was used in the studies.

5.1 Static Margin Considerations

Optimum static margin for each value of aspect ratio and wing loading was found by varying

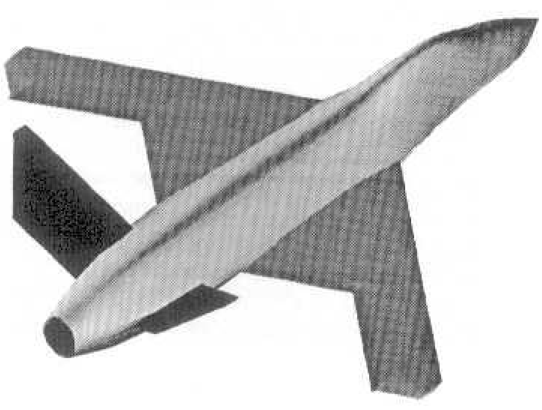

Figure 6 UMAV Orthogonal

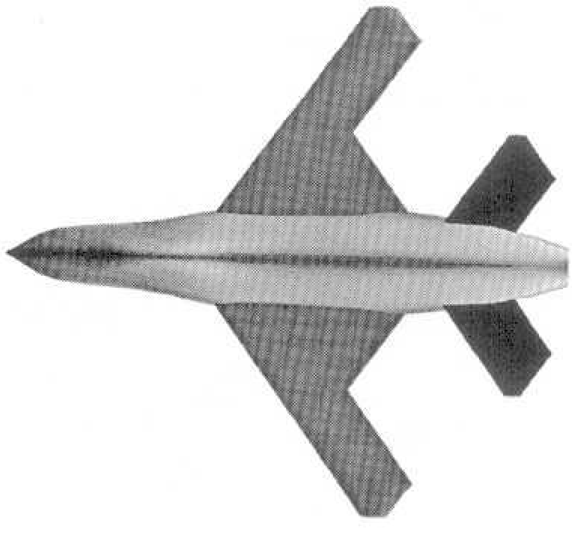

Figure 7 UMAV Plan View