5.3.7 Wing Loading for Cruise

Raymer introduces two new coefficients: C_{D_0} is the zero-lift drag coefficient, and e is the Oswald span efficiency factor. The calculation of C_{D_0} requires the summation of the drag of each part of the airplane (e.g., fuselage, wing, tail, etc.), and is somewhat tedious, requiring some experience to put values on factors such as interference drag (Raymer Section 12.5). A slightly better method of estimating C_{D_0} than the values given in section 5.3.7 is to estimate the value of S_{wet}/S_{ref} using the equation:

$$\frac{S_{wet}}{S_{ref}} = \frac{A}{wetted\ aspect\ ratio} \tag{5.3.7.1}$$

The wetted aspect ratio can be estimated from Raymer Fig. 3.5. The value of C_{D_0} may then be estimated from:

$$C_{D_0} = C_{f_e} \frac{S_{wet}}{S_{ref}} \tag{5.3.7.2}$$

The equivalent skin friction coefficient, C_{fe}, can be found in Table 12.3. C_{fe} is an average skin friction coefficient for the whole airplane, and includes component interference effects.

The Oswald span efficiency factor e is a measure of the efficiency of the lift capability of the airplane. For a subsonic airplane which has a wing with a relatively large nose radius, so that the flow is attached at most angles of attack up to the approach to stall, decrements from optimum efficiency result from either deviation of the distribution of spanwise from elliptical, or from sweep effects. For a supersonic airplane which has a wing with a relatively sharp leading edge, loss of efficiency is due to flow separation, resulting in loss of "leading edge suction". This is discussed in detail in the annotation to section 12.6.1.