

MODEL AIRCRAFT DESIGN

From a composite number of articles on the internet edited by the Windsock

This article, obtained from a number of articles posted on the Internet will give you some concept parameters for design. At least check them out by comparing with a set of plans of a model that has proven a good flyer in the past.

DESIGN PARAMETERS

Wingspan.

Firstly decide on a wingspan, everything else flows from that. One of the first things you need to estimate is the *wing loading* and how to calculate it. If for example your wingspan is going to be 80in. long with the width (chord) of 13 in. then your wing area will be $13 \times 80 = 1040$ sq inches of wing area. The term *aspect ratio* is the width of the wing (chord) divided into the length (span). Generally a sailplane has a greater aspect ratio, maybe even 20 to 1. The wing we have just decided upon has an aspect ratio of 80 divided by 13 which equals about 6 to 1. This is a good start for a basic airplane. The larger the model, the higher the wing loading the aircraft can handle.

The horizontal stabilizer

The horizontal stabilizer should be equal to about 12 to 15% of the wing area with an aspect ratio of about 3 to 1.

The Vertical fin and Rudder

The vertical fin and rudder should equal about 33% of the Horizontal Stab with the rudder area about 1/3 rd. of that area.

Fuselage length

The length of the fuselage should be about 75% of the length of the wing. The nose moment around 25 to 30% forward of the wing balance point. The tail moment in the area of 65 to 70% of the fuselage length (and aft of the balance point).

Fuselage height about 10 to 15% of the fuselage length. Aileron area should be about 10% of the total wing area with the length of each aileron about 8 times its width.

LANDING GEAR POSITION

Landing gear placement should have the axle in line with the leading edge of the wing on a tail dragger. On a tricycle gear

you need the main gear slightly aft of the balance point. If you run a vertical line from the wheel touchdown point and then a line from there through to the C of G. and note the angular difference, it should be between 15 and 25 degrees on a tail dragger.

Nose moment

Is the distance from the balance point of the wing (approximate aerodynamic centre of the lift) forward to the prop. Most wings should be balanced initially 25% of the average chord back from the leading edge of the wing.

The wing

Aircraft fly because of the wing. Most average aircraft under average conditions land because the wing stops flying. The wing stops flying before landing ... or it loses lift or whatever you wish to call it.

Generalities

Most models need to be balanced 25% or more back from the leading edge of the wing. To make your model less sensitive on the initial flight, you can bring it forward. To make your model more sensitive you can take it back to 33% of the wing. (The further aft you move the balance point the more sensitive the elevator controls become.

Stall Characteristics

The inner portion of the wing must stall before the outer portion, and you either want a sharp stall or a gentle stall. The shape of the leading edge defines whether you have a sharp stall or a mild one. If the leading edge is sharp, the stall is likely to be sudden. If the leading edge is dull/blunt the stall will be gradual.

A rectangular wing needs little or no washout, as the inner panel just naturally stalls before the outer panel. However, a tapered wing needs some washout.

The aerofoil

Just draw out something that looks like an aerofoil and try to make the high point about 25% back from the leading edge. If you want a more aerobatic aircraft then make the curvature of the top and bottom at the same point. Draw a datum line after you have drawn a leading edge circle

and make a mark there. Then plot a straight line from that mark to the trailing edge of your airfoil. This is the datum line.

THICKNESS OF THE WING

A good number is 12 to 15% of the chord. The thicker you make it, the more lift, but also the more drag.

Wash out

If you want a tapered wing then wash out will be needed. The greater the taper the more the washout. About 3 degrees is ideal. This equates to approximately 1/8 to 3/16 of an inch up, at the wing tips of the trailing edge of a 60 inch wingspan.

If you don't have washout the tip of the wing stalls before the middle of the wing. When that happens the tip drops violently when it loses lift and, causes the model to suddenly drop a wing ! NASTY!

WING INCIDENCE

Above we discussed the datum line of the airfoil. You will need to draw this kind of line for the fuselage. Pick out a spot about midway, vertically on your fuselage side and draw the line from nose to tail. Usually you would place your horizontal stabilizer flat in relation to this line. Your wing placement in relation to the fuselage datum line can vary some. Again generally, it should be zero degrees incidence from this line.

The heavier wing loading your model has the more you want the wing to have positive incidence. This means that the leading edge of your wing, when viewed looking at the side of the fuselage drawing needs to be up from 1 to 2 1/2 degrees. When you fly your model you will want to observe just how it flies. Is the tail end hanging down or is it way up? If it is hanging down that means you don't have enough positive incidence in the wing so you will need to raise the leading edge of the wing a degree or so. Or the

reverse if the tail is too high!

THRUSTLINE

If you look at the side of your engine it is pretty easy to imagine the line of the crankshaft from fore to aft. This is the thrust line of the engine. When you mount your engine you can build in up to 2 to 3 degrees of right thrust; and up to 2 to 3 degrees of down thrust. This imaginary thrust line is in relation to the datum line you drew on your fuselage.

Thrust Line flying checks

Get your model tracking straight and level at altitude, then cut the throttle. The nose should drop gradually. If the model's nose climbs then you have too much down thrust. If the reverse happens then you have too much upthrust. If you have designed a tail dragger, it will be very easy to tell if you have enough right thrust, when you try to take off. Your model naturally tries to turn to the left. If you have set it up just right, your model will track straight ahead on take off.

BALANCE

Generally all that is needed is the balance point of the wing. It needs to be about 25% to 33% of the chord back from the leading edge. The further rearwards it is, the more sensitive the elevator control the more difficult the model is to fly.

In addition you should balance your model laterally. Put one finger on the end of the crankshaft and the other finger on the tail. If it continually rolls to the same side, then that side is too heavy . Add lead to the light wing and there you have it in a nutshell!

The above parameters are all approximate, but should be the basis of a reliable starting point. Obviously trial and error comes into its own as with all new designs.

Good luck and enjoy the process!