How do I find the proper C.G. on a model when prints or information as to its suggested location is not available? On a constant chord wing it would simply fall 30% back from the leading edge of the wing. On a tapered wing it requires a bit more planning. Start with a point 30% back from the L/E at the wing root. Next go to the tip and establish a point 30% back from the L/E at the tip. Strike a straight line between these two points. We will call this line (A). Next, measure the length of the chord at the wing root. Establish a point using this measurement directly in front of the very tip. Now, measure the tip chord, and place a point using this measurement directly behind the center root rib. Strike a straight line between these two points. We will call this line (B). If you now extend a line outward from the C/L of the fuselage exactly 90 Deg. to the point that (A) and (B) intersect, you will have a 30% C.G. position established. This will work regardless of wing taper configuration, and does the same even on swept wings. If you have a biplane where the wings are staggered, it requires one more step. Strike a line from the intersecting point of (A) and (B) on the top wing, down to the same point on the bottom wing, then measure half the distance of this line. Now the 90 Degree line from the C/L of the fuselage should intersect this half way point, to establish the proper C.G. location. The only wing plan form that this method will not work is on an elliptical wing such as the Spitfire, or the Cap 20L.

BIPLANES

Most full scale aerobatic biplanes such as the modern Pitts design use a full symmetrical airfoil, same as the monoplanes described in the preceding paragraphs. Models have followed this trend and practically all of the biplanes available today employ a symmetrical section, only varying the percentage of thickness in the airfoil. Reasoning behind this, as with the monoplanes, they perform equally well in positive or negative "G" maneuvers. One thing that especially came to the forefront in the earlier days when engine size available determined the size of the biplane, they were by no means capable of a "Ballet" type performance. I attribute this to several factors such as lower aspect ratio wings, constant chord wings, short moments, more drag, etc. Wing loading (Wt. per Sq. Ft. wing area) on biplanes cannot be applied in the same way as monoplanes. For instance a 32 Oz wing loading on a monoplane may make it an ideal aerobatic machine, while a 32 Oz. wing loading on a biplane will not offer the same degree of forgiveness.

I experienced this "Dragonfly" characteristic in my first attempt at biplanes with a Pitts S-1S model that I built in the early 80's. I never did crash it, and it still is in a friend's workshop in flyable condition today. It did not however enhance any flying ability that I had acquired at that time. Later on in the 80's I became infatuated with another biplane built by Kermit Weeks for full scale IAC competition. He first built a "Weeks Special" and it was basically a rework of a Pitts S-1S. Kermit made the following changes in relation to the Pitts. He swept the lower wing same as the top wing, took out all of the bottom wing dihedral, and both wings were mounted at 0 deg. to the thrust line. In his first international appearance with the Special, he placed second in world competition. Not satisfied with being second in the world, he then built an entirely new biplane from scratch, and called it the "Weeks Solution." This turned into a true winner and he accomplished his dream in winning the world IAC championships.

The Solution was my choice for my next biplane, and I did a lot of research before finalizing the prints. Uppermost in my mind was my theory that the lighter the wing loading, the better the aerobatic performance. Another way of achieving this desired lightness was to consider a non symmetrical airfoil that would handle the weight better, while not interfering with the negative "G" performance of the aircraft. This led to more research into the airfoil subject and I found that another prominent name in full scale competition came to the surface. The late Leo Loudenslager had designed a monoplane called the Laser 200 and proceeded to win 1st. in IAC world championship competition. The airfoil used in the wing design was an NACA 23012. Henry Haigh later on also used this airfoil on his Superstar to win 1st in IAC competition. This particular airfoil was a semi-symmetrical section where the thickest part of the rib from the thrust line up was at 25% of the chord, while the thickest part of the rib from the thrust line down was at 40% of the chord.

I made up my mind that this was going to be my airfoil of choice for the new Solution, and I am not at all regretful of this selection. The 23012 semi-symmetrical section choice, along with sweeping both wings has produced a model that is fully aerobatic, yet has as much forgiveness as any trainer that I have previously flown. The speed envelope on my present Weeks is 108 MPH top speed, and 10 MPH landing speed. The 23012 airfoil has none of the characteristics shown in other semi-symmetrical sections, and is just as much at home inverted as upright, as well as in negative "G" maneuvers. An-

other advant
efficient at h
section, and
cal model fly
section is ap
the Weeks cc
common des
3 Deg. of swe
the same bot
back up these
can definitely
The p
gine in relatio
as many diffe
els on the ma
thrust line of
as the engine
thrust line of t
Deg. positive,
and presents a
amount of dra
thrust line cau
configuration,
that the builde
tive route whe
This pa
airfoils, but has
performance. I
with open bays
ic purposes. I
same model, a
tics do not cha
characteristics
remember full s
ing about the s
their "Rag wing
of today's mode
some place cap
ing and trailing
effect. I am not
this type to com
makes it more e
design, let's dis
Some models sh
while others rev
mounting. On t
for the followin
aerobatic aircra
ential aileron de
their axis rather
tial in this case
hinging is done
when we taper
top to bottom, to

other advantage to this airfoil is that it is much more efficient at handling weight than a full symmetrical section, and would equate to a 20 Lb. full symmetrical model flying like a 17 Lb model when the 23012 section is applied. Also having both wings swept on the Weeks contribute to the stability of the model. A common description of sweep in the "Old days" was 3 Deg. of sweep equals 1 Deg. dihedral, and it works the same both upright and inverted. I am not able to back up these numbers with researched facts, but I can definitely state that it works.

The positioning of the wing, stab, and engine in relation to the thrust line of the biplane has as many different interpretations as there are models on the market. The Weeks is designed with the thrust line of both the top and bottom wings, as well as the engine mounted at 0 Deg. in relation to the thrust line of the fuselage. The stab sets at 1-1/2 Deg. positive, which lets the model fly "On the step" and presents a very clean target with the minimum amount of drag. Mounting the stab at 0 Deg. to the thrust line causes the model to fly in a "Landing" configuration, and I can spot one flying in a minute that the builder did not follow the 1-1/2 Deg. positive route when mounting the stab.

This paragraph is not directly associated with airfoils, but has a very definite bearing on a model's performance. I am a firm believer in built up wings with open bays, rather than full sheeted, for aerobatic purposes. I have tried both configurations on the same model, and while the high speed characteristics do not change much, it definitely effects the stall characteristics and landing speed of the model. I can remember full scale pilots in prior times complaining about the same characteristics when they had their "Rag wings" replaced with metal ones. Many of today's model designs use foam wings and I notice some place cap strips between leading edge sheeting and trailing edge sheeting to give the open bay effect. I am not familiar enough with foam wings of this type to comment on whether this is for looks, or makes it more efficient. While on the subject of wing design, let's discuss aileron hinging for a moment. Some models show center hinging the ailerons, while others revert back to the top hinge style of mounting. On the Weeks, I use the top hinge method for the following reasons. First, all aircraft, especially aerobatic aircraft require a certain amount of differential aileron deflection in order for them to roll on their axis rather than to "Trade wingtips." Differential in this case means more up than down. When hinging is done from the top, the "V" that results when we taper the leading edge of the ailerons, top to bottom, to provide travel clearance, we present less surface on the down aileron position, than we do the top. This results in differential, but may still require a bit of fine tuning on the transmitter to achieve ultimate roll performance. Regardless of the style of ailerons, the gap must be sealed between the leading edge of the aileron and the trailing edge of the wing where they mount. Sealed ailerons make them much more efficient, resulting in requiring less throw for the maneuver desired. This also produces a much cleaner aircraft in vertical rolls. The less aileron deflection in vertical maneuvers keeps the ailerons from creating unnecessary drag. Even though one aileron is up and the other down, they still work as brakes when activated.

In finalizing this article, the impression that I wish most to leave with the readers, is that this is a brief history of my experiences in the modeling field. If any of my suggestions are in conflict with your current model, it simply means that the designer took a different approach, and I sincerely respect the methods that he used to achieve his goal.

Miles

> "I am a firm believer in built up wings with open bays, rather than full sheeted, for aerobatic purposes. I have tried both configurations on the same model, and while the high speed characteristics do not change much, it definitely effects the stall characteristics and landing speed of the model."