August 2010

Training – Aircraft Balance

In this column we try to cover material which is relevant and pertinent for student pilots in training as well as other new pilots. That material is not intended to tell a student "how to move the sticks" but is intended to supplement the "hands-on" information the student is learning from our staff of instructors. The importance of having the proper **longitudinal balance** in an aircraft is another example of this kind of material. Note here that at this time we will not be concerned with the lateral balance of the plane.

I don't think I am much different than many other pilots in that when I finish assembly of a model I am anxious to "try it out". While it is a good thing to have this kind of enthusiasm, we have to be careful that we do not "hurry" or "shortcut" any of the important final steps that might adversely impact the flight characteristics of our aircraft. And if you doubt the importance of the balance issue, let me tell you that I can remember a partially loaded commercial airline flight years ago on which the pilot came into the cabin and asked a number of passengers to please move forward in the cabin to improve the balance of the plane. Paying attention to this detail is particularly important for student pilots who may not be quite as proficient at "saving" an ill-handling plane as a seasoned pilot might be.

A new or student pilot might wonder "well if I built this plane just like the plans said, why would it not be balanced properly". There are actually several things which can affect the final balance of the plane including engine or motor selection and mounting position, spinner, propeller and muffler selection and the placement of the radio receiver, batteries and other equipment. In addition, the plans or instructions for a kit or an ARF may or may not lead to the best balance for your plane.

The whole issue of assuring proper balance is a rather deep subject and there have been many articles written about it. While it is way beyond the scope of this column to cover more than a small fraction of what is known about the subject, what this column can do is make the student pilot **aware of the importance of assuring the proper balance** of his/her plane. To do this we will discuss the (sometimes evil) handling characteristics of a poorly balanced plane. Remember here too that if the balance is off by as little as ¼ of an inch in either direction the results may make themselves known in an ever-uglier way.

Let's consider <u>two properties</u> of any plane. First is the <u>center of gravity</u>. We are mostly all familiar with that concept, but for this discussion, just consider where the center of gravity is along a line from the nose to the tail of your plane. Second, think of the lift generated by the wings, and in particular consider that at someplace along the longitudinal line from nose to tail is the exact spot, where at a given speed, just as much lift is generated forward of the spot as aft of it. We can call this the <u>center of lift</u> or some call it the aerodynamic center. Now if you think of the plane kind of like the "see-saw" on a children's playground and the <u>center of lift</u> as the

fulcrum, you can see that if the center of gravity is forward of the fulcrum the plane will want to go nose-down. If the center of gravity is aft of the fulcrum (center of lift) the plane will want to nose up. To compensate for either of these conditions we could dial in more deflection in the elevator, but this usually leads to other problems.

OK, so then what would happen if the balance is not right? First, let's take the case where the center of gravity is too far forward, and the plane is thus "nose-heavy" and tries to go into a dive. To compensate you could adjust in an extra amount of "up" elevator to push the tail down. But this does a couple of not-so-good things. First it increases drag on the plane. Probably more importantly, if you ever go to fly inverted, you will find that the excess "up" elevator now will work against you and you will have to correct with an extra large "down" elevator just to fly level. At this point you begin to realize that something is really wrong. In an extreme case, you may find that you don't even have enough "down" elevator to keep flying level! That will get your attention!

So now think of how it is if the center of gravity is too far aft of the center of lift. It is easy to see that the tail will want to "sink" and the nose will rise. But more importantly, the whole system becomes increasingly unstable as the center of gravity is moved rearward, and at some point the plane simply can't be flown. The tail starts to wag the dog. If you start to move the center of gravity rearward and notice that you have to really "stay-on-top" of your flying or the plane feels "nervous" in pitch, you are probably at or near the limit of change. Note also that the distance from the forward-most desired location of the center of gravity to the rearward-most location is quite small. Typically on an average plane it is only about ½ inch.

And so we have now only touched on the subject of balance but hopefully it has become clear that **it is really important to check and assure proper balance on your plane prior to flying.** It would be a shame to put so much effort into a model and then lose it because of one important omission. In some future column we may discuss techniques for checking balance both on the ground and in the air, but for now I suggest that any new or student pilot read the instructions with the model, do a preliminary static balance as recommended by those instructions and discuss the issue of balance with a member of the club's training staff prior to your first training flight.

Until next time; remember to try something new each time you fly.

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