The Dive Test

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A topic of great interest on the internet, and in various soaring newsgroups is the dive test. Mostly there has been a lot of confused discussion, with more verbiage than knowledge exchanged. Here for you newsletter readers, is our attempt at a simple, straightforward discussion. First, some plain English definitions.

Angle of Attack (AOA):
The angle an airfoil makes to the oncoming airflow. An airfoil will stall at the same AOA regardless of wing loading. Max L/D will be attained at the same AOA regardless of wing loading. Max endurance will be attained at the same AOA regardless of wing loading. What does change with wing loading is the airspeed associated with any specific AOA.

Positive Stability:
For positive stability, the angle of incidence of the tail plane is set so that it provides down thrust. This down thrust is counteracted at any airspeed at which the model can be trimmed for level flight (any AOA within the range of the airfoil) by a forward CG. As the model accelerates, the downward force on the tailplane increases, (force proportionate to the square of the airspeed). Since the CG stays the same, forces are not balanced, and the nose is raised. As the nose of the model comes up the model decelerates, force due to the forward CG is then greater than force due to tailplane, so the nose drops. Very simple! The model tends to return to trimmed attitude and airspeed.

Neutral Stability:
If the angle of incidence of the tailplane is set so that the tailplane generates no up or down thrust, and the CG is more aft to balance moments, the model will tend to keep on accelerating in whatever direction it is pointed. This is called neutral stability, and is most efficient (theoretically). With neutral stability, in a dive, the model will keep on accelerating in a straight line until additional forces come into play. Impact is one force that comes to mind.

Negative Stability:
When the tailplane is set to generate lift, as the model accelerates, the tail will come up and the nose will go down. This model can be made to fly, but will demand constant pilot input. In a dive, resultant forces are such that the nose tends to tuck.

No matter what kind of stability a model has, it can be trimmed to fly. The difference is that with positive stability, the model tends to return to the trimmed airspeed, with neutral stability, it tends to assume attitudes which cause it to depart rapidly from the trimmed airspeed. Negative stability is good for F-18s, but not recommended for novice pilots.

The "Dive Test" is in essence a test of stability. If done properly, the test can be a useful aid in trimming out a new or unfamiliar model. If done improperly it can cause great confusion. Further, most experienced pilots don't need to do a dive test, because they can determine stability in the course of a normal flight. They already know how they want a model to "feel".

For you less experienced guys who want to try a dive test, here's how to do it right.

Pick a reasonably still air day.

Attain a good working altitude, about 600 feet minimum.

Trim your model for hands off level flight. If you can't do this, chances are your model's stability is neutral to negative, or possibly, your piloting skills are so weak a dive test won't help you anyway. Land and add a little nose weight. If in doubt, get a more experienced pilot to fly your plane.

Once trimmed in level flight, roll into a 45 degree bank, but use no elevator input. Once the nose begins to fall, level the wings. Do not simply push the nose over from level flight, since hysteresis effect on elevator controls may result in un-intended nose down trim. If the nose does not fall, you still have neutral or negative stability, land, add nose weight and return to step 2.

Observe. Keep your hands off of the sticks and trim_ If the model recovers to a nose-up attitude rapidly, or even overshoots into a stall, you have too much positive stability. Remove nose weight. If the model begins a gradual pull up and recovers to level flight without too much gyration, you've hit it right, don't mess with anything... If the model keeps on accelerating in a dive, or if it tucks, stability is neutral or negative. Land and add a little nose weight. Unless you hit it right, return to step 2.

Why neutral stability is not actually the most efficient:
Theoretically, neutral stability is the most efficient set-up for a model, but in the real world, humans are a part of the loop, and we tend to complicate things. With slightly positive stability, we can fly hands off, we make fewer control inputs, and the fewer control inputs, the more efficient the flight. With neutral stability, we must constantly make inputs and efficiency goes down. With positive stability, when discontinuities in the air mass are encountered (thermals, sink), the model will react without pilot input. Rising air adds a positive vertical component to airflow, since the model tends to fly at the same attitude (AOA), the tail goes up giving a nice indication of lift. Sink adds a negative vertical component, and the tail goes down, indicating the model is also coming down. Since we are not aboard the model, we can't read the variometer and we need these external clues to detect lift (forget the sniffer). These clues, provided courtesy of positive stability are nice to have. On the other hand, with neutral stability, the model has no preferred attitude, and when discontinuities in the air mass are encountered, the model will maintain the same apparent attitude to observers on the ground. Thus, the model will fly very efficiently through lift and right on into sink with no notice given.

All said and done, the better the pilot, the less positive stability he will need, and the closer to max potential efficiency he can fly. In my observation, none of us are as good as we really think we are, and we can all use a little positive stability.