PITCH, ROLL AND YAW

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In the beginning most all the cards were on the table. Everyone expecting to be the first to fly knew he needed a power plant, some sort of an airscrew fastened to the crankshaft, wings like a bird, some wheels or skids and a place to sit. Later, the idea to get the nose pointed up and down was thought to be necessary and the ability to turn seemed reasonable too. So, in their plans, most all wannabes put movable surfaces at the rear and the operating handle near the seat. All except the Wright brothers; they alone had an ace in the hole.

As bicycle guys, they proposed that you had to lean in the direction of the turn. You didn't just move the handlebars. First you leaned and then carefully swung the handlebars in the same direction, coordinating both according to the speed at which you were moving. This complicated things immensely, but they flew captive gliders which confirmed their thoughts and subsequently paved the way for wing warping on their first manned airplane. Warping the wings, we now know, was roll control. Pitch control was done with horizontal moving surfaces and yaw control with vertical surfaces.

As dedicated Free Flighters, we do it the same way, except our roll control is fixed. We simplify it by building in the wing warps. We move our horizontal stab up and down for pitch control and use a vertical rudder tab to control yaw. The same method Wilbur and Orville used is simple and clean. In a good contest model, ground adjustments in these two surfaces are all we need to get a beautiful climbing spiral that will lead to a repeatable, no stall transition to glide. The difficulty comes in identifying which surfaces to adjust.

First, a few words about torque. Torque is the force opposite the rotation of the propeller. Newton's Third Law of Motion is, "Every action has an equal and opposite reaction". This law has not been repealed. Therefore, the torque force wants to roll the airplane counter-clockwise as viewed from the pilots' seat, the same direction as the roll necessary for a right hand climbing spiral. The torque force is not right or left (yaw) or up and down (pitch) and cannot be supervised by tweaking the stab or rudder tab position, although many try to do so.

We build in roll control primarily so that we don't have to adjust it. It also simplifies construction. Tiny amounts of warp built into the wing structure before covering do a marvelous job. Leaving out pitch control for a moment, the roll/yaw coordination required is quite straightforward. If we want to climb to the right, we want the right wing to rise in the climb (roll) and the yaw to aerodynamically drive the nose to the right to keep it headed in the same direction relative to the roll. That "best" climb comes when we are able to separate yaw and roll in our heads and then adjust yaw with the rudder tab for the amount of built-in roll.

Pitch control is used to keep the coordinated roll/yaw forces in the correct climb attitude for the amount of power available. A continuous tight barrel roll about the vertical is a good example of the correct amount of yaw required for the amount of roll we built into the model, but it makes for hammerhead stalls and the consequent poor glide unless we also use timer actuated pitch and yaw surfaces at precise moments. A wide-circling, slightly nose up, fast climb gaining little altitude may also be a good example. The difference in the two is in the amount of pitch control. The barrel roller could use less pitch (negative), the wanderer needs more (positive). Positive is nose up, but watching the model and its pattern can fool even the most experienced flyer. The most important concept is that each force is very much independent of the other and is easily controlled by the one adjustment committed to that force. That is the easy part. The hard part is in recognizing which force needs to be altered and by how much.

Left climbs fight the torque, so if we choose that, we build in an otherwise unnecessary complication. Different configurations of models with different engine locations, thrust lines, pylon heights, wing planforms, etc. make for differing looks, but no difference in the effect of torque or the method of force control. Since torque is constant in the climb, roll due to torque is hardly ever noticed except on smaller rubber models with big props and lots of rubber and then only immediately after launch. Torque is not seen after the first few feet of climb on a healthy sized contest model with a powerful engine running smoothly because the aerodynamic forces are changing with airspeed and are much greater than the constant torque force.