MY Y-TAIL THEORY

By Kurt Krempetz

An article found recently on the internet

Introduction The tip launch freeflight glider has grown in popularity since 2006. Currently, most successful tip launch gliders (TLGs) have a Y-tail incorporated in their design. There have been some very successful TLGs that do not use a Y-tail. For example, the current World Record Holder F1N does not use a Y-tail, it employs a tail rudder system shaped like a plus sign. This raises the question of which tail is better for tip launch gliders, the Y-tail or the + tail.

History of the Y-Tail I believe the Y-tail was developed and became popular first in England. Both Mick Page and Mark Benns incorporated them on many of their designs, including Javelin Style hand launch gliders and catapult gliders. These designs were very successful. Then the concept of TLG came along and Mark used the Y-tail on his Spin-Up. This model set the "standards" for many of the future TLGs and has made the Y-tail a very common feature of TLG's.

My Experiments In the fall of 2005, I started experimenting with TLG's. My success was very limited. I watched Mark Benn's set the World Record (which has since been broken) flying his model at the Kibbie Dome, where he was flying a flight pattern of left-right; a very different pattern than the typical javelin style HLG, where the pattern was right-left. I took a few old Supersweep models and tried to trim them out with the left-right pattern. It was clear from these tests that I need a lot more rudder to keep the model from Dutch rolling into the ground when tip launching. I really never got anything to fly well.

At the 2006 Nationals, I watched Bruce Kimball impressively fly a TLG, winning the event. Returning home, I tried to create a basic copy of his and Mark's design. This is the Round-a-About, the plans for which are posted on the AMA Glider website. My efforts this time were very successful, and I contributed much of the success to the Y-tail and large amounts of positive incidence in the model.

Tail I think many others that built TLGs started having success and the Y-tail was a noticeable feature in most of these models. It was clear that in order to successfully tip launch, more rudder area was needed to compensate for the yaw the model undergoes while being tip launched. Some modelers believe that the rudder area needs to be on the top and bottom of the fuse to prevent torque. So some designs choose the + tail configuration to add this extra rudder area. Basically, a + tail is one where there the rudder area is about the same on both the top and bottom of the fuselage and has the horizontal stabilizer and the rudder about the same size. The + tail is used for this purpose, however, the Y-tail accomplishes the same thing, also adding additional rudder to the plane.

Many Ways to Solve The Problem There are always many ways to solve the same problem, most can be made to work, but one way is usually superior. At this point of evolution of TLGs, it is clear either a Y-tail or + tail can be made to work. But which one is better? I have not done a lot of experimenting with the + tail, but I currently believe the Y-tail is the better configuration for TLG. I'll explain why.

My R/C Pattern Days Before I started seriously flying freeflight in 1999, I was heavily involved in RC Aerobatics or Pattern. This was a fun sport which I enjoyed. As with freeflight gliders, I preferred to design my own models, rather than just duplicating someone else's work. In the early '80s, before R/C radios had a mixing feature, a pattern model needed to be designed so it could do a nice knife edge, where the plane is flying on its side, perfectly parallel to the ground. Back then, what most designs did, was when the model was rolled to its side and rudder was applied to keep the model from losing attitude, it did not fly straight. Two things usually occurred 1) was the model rolled back to level flight and 2) the model pitched down. The goal was to have a model which could maintain a perfect knife edge flight. If this could be accomplished, it made the flight look more professional. It took a few years to finally understand how to design a model that could maintain a knife edge flight. It was concluded that the issue was a coupling effect. This meant that when rudder was applied (yaw), the model coupled in (automatically) roll and pitch. To affect yaw-roll coupling, you needed to change the dihedral in the wing. To change yaw-pitch coupling you needed to change dihedral in the stab. It was also discovered that the relationship (height) of the wing to the stab, affected both of these coupling issues. So in the early '80s, new pattern designs emerged, where the wing had less dihedral, and anti-dihedral was added to the stab.

What's the Relationship? Anyone that flew javelin style hand launch gliders knew that very little to no incidence was desirable. If one put a lot of incidence (like a 1 degree) the model would loop. But one feature on the TLG designs is the large angle of incidence one puts in the wing. Many designs use up to 2 or 3 degrees, something if done with a javelin model would be a "for sure" loop. How do you get away with so much positive incidence in the present TLG designs? My theory goes back to the yaw-pitch coupling. Javelin style launching results in significantly less yaw exerted in a model, whereas tip launch has the yaw from the spinning motion. A model with a Y-tail has a lot of dihedral in the stab. From my pattern experience, I know that more dihedral equals more down pitch. You can put a lot of incidence in the model if it has a Y-tail, because at the beginning of the launch the model yaws, the Y-tail causes down pitch. As the model stops yawing, middle to end of the launch down pitch goes away. The positive incidence enables the glider to transition well. As a side note, the more positive wing translates to a further forward CG; and my experience is that TLGs need a much further forward CG than a Javilin style model.

How Does The Y-tail Effect The Yaw-Pitch Coupling? To learn more about why dihedral in the stab causes down pitch when the model is yawing, read the article on wash-out which is posted on the AMA Glider website. The same principle applies: When the model is yawing, the airflow across the stab in not parallel to the fuse, but is going across the flying surface at an angle. This changes the airflow, and if

the model is yawing left, the right side of the stab has pressure pushing it up and the left side of the stab has pressure pushing it down. Remember, we are yawing (assuming yawing left), so the right side of the stab is traveling faster than the left side of the stab. Therefore, the right side has more of an effect, since the pressure is pushing it up the nose is pitched down.

Conclusions I believe this Y-Tail Theory, better described as yaw-pitch coupling, explains the observations we have seen in TLG. The yaw during launch (discus launching), allows one to put more incidence in the model (because of the Y-tail) without causing a bad launch trajectory. The additional incidence creates a more pitch stable model, which gives you a nice transition. These are all nice features which makes the Y-tail a very attractive design feature for freeflight tip launch gliders.