All about F3P

by Dave Lockhart

The modern day F3P plane at first glance can be very intimidating and seemingly unobtainable. However, as with many forms of competition, there is a progression that starts from readily available equipment.

Before digging in, it is worth noting that flying indoors in itself has a learning curve. Box limits are absolute and gaining a comfort level close to walls and the ceiling can take some time. Hence, initial indoor flying benefits from durable and easily repairable planes.

First up, no assembly required is the E-flite UMX Yak 54. For about $150 street price, the Yak can be obtained with a handful of 1S lipos (Hyperion brand runs very well) and a multiport lipo charger. Add a DSMX compatible transmitter with a little tuning on rates and expo, and the Yak is capable of very credible precision aerobatics. This plane really is a quick and easy option for getting a start with indoor aerobatics. The lightweight carbon fiber reinforced mylar covered foam framework is surprisingly durable and amenable to repairs with foam safe CA and tape.

The Yak includes the AS3X gyro system with several pre-programmed gyro modes. While the gyro system makes the plane illegal for competition, the Yak is still a great plane to get acquainted with indoor aerobatics. The standard "rate mode" is best for pattern flying and yields several notable advantages. The gyro system makes the plane "feel bigger" than it is (a mere 17" wingspan); more accurate, precise, and locked in. And it does a great job of minimizing the effects of turbulence and improves the aerobatic trim of the plane. Knife edge coupling is reduced, rolls are more axial, and rudder inputs in pitching maneuvers are largely completed by the gyro. The biggest thing the Yak is lacking compared to a larger F3P plane is slow and constant flight speed.

Next up, is the RC Factory Clik R2. I owned the original V1 Clik as well as the V4 Clik and the current version is the R2. This EPP foam kit is available in the USA from Twisted Hobbies, and most definitely requires assembly. Construction is relatively straight forward using foam safe CA (brittle, but quick) or a flexible glue, like Beacon Foam-Tac. Foam-Tac can be used as a traditional glue, or as a contact cement and adds a minimal amount of time to the build. The EPP structure of the Clik is quite durable and flexes in crashes, and potential crash damage is further minimized when assembled with Foam-Tac.

The number of motors, ESCs, lipos, and servos to equip the plane are plentiful. Equipment options make a big difference in the flying weight. Numerous options/packages to complete the plane can be found on the Twisted Hobbies website. A Clik ready to fly with a handful of batteries can be achieved for less than $250.

A typical Clik intended for flying outdoors (calm mornings and evenings) can be expected to weigh in at 140 +/- grams. For outdoor flying, a larger motor (15-20 grams) and lipo (250-400 mah, 20-30 grams) is beneficial to maintain an overall higher flight speed and reduce crab angles. A Castle Creations Talon 15 and APC 9x3.7 are good starting points. At the higher flight speeds, larger servos are needed to maintain good control authority. For an outdoor Clik, 7-9 gram aileron servos suffice (20+ oz/in torque), with rudder / elevator servos in the 5-7 gram range (8-12 oz/in torque). The receiver need not be full range, and should be the lightest possible with connections matching the servos.

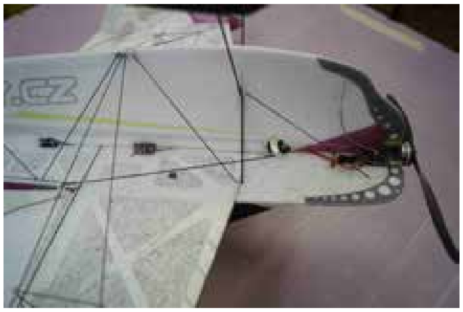
A typical Clik intended for indoor flying should weigh less than 120 grams; the lighter the better. Small changes in weight are much more noticeable in indoor spaces; increasingly so as the space gets smaller (especially ceiling height). With careful building and equipment selection, 120 grams can be achieved. Several years ago, I opted for some lighter components and did some moderate lightening of the airframe and components to produce a Clik V4 with a flying weight of 99 grams. Equipment I used -

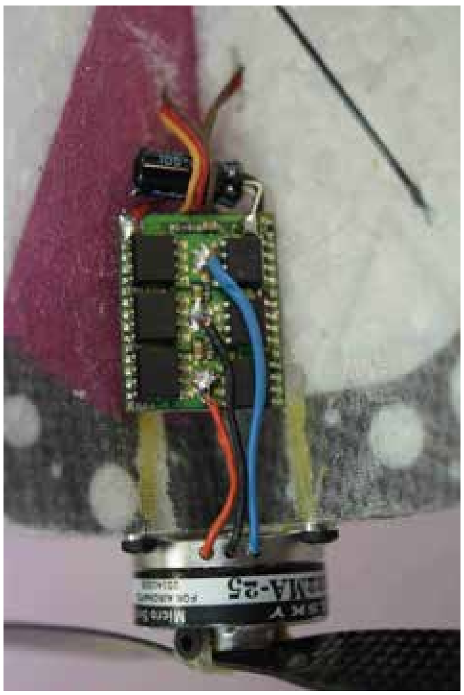
Motor – Dualsky XM2212MA-25 2160 KV, 10.5 grams
ESC – Castle Creations Talon 15
Prop – PT 9x3i carbon fiber
Lipo – Hyperion 2s180
Aileron Servo – JR DS188, 6 grams, 12 oz/in torque, 0.08 seconds
Rudder / Elevator Servos – Power HD DSP33, 5 oz/in torque, 0.07 seconds.

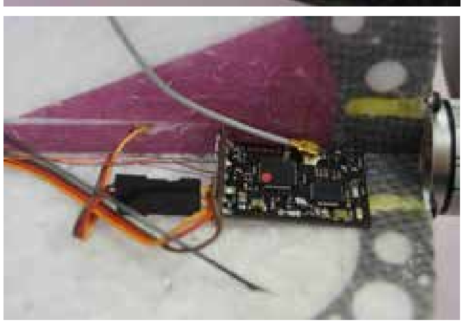
"Moderate lightening" being a relative term of course. On the airframe itself, I used a router base on a Dremel and "milled" the foam to partial thickness in various areas of the plane. To recall, this saved about 5 grams (almost 10% of the completed bare airframe). I did not replace the carbon fiber rods with carbon fiber tubes. Doing so would have saved approximately 3 grams.

Looking at the equipment, there is quite a bit of "low hanging fruit". I removed the case bottoms on the servos and the entire case on the receiver. Heatshrink was removed from the ESC and lipo. Very simple and easy to do.

The next opportunity for saving weight is in wiring and connectors. I removed all the servo plug pins on the receiver (excepting the throttle channel) and the servo leads from each servo. Using 30 AWG magnet wire, all connections between the servos and receiver were directly soldered. The wiring on the motor side of the ESC was removed and the motor wires were soldered directly to the ESC. The balance lead and power lead on the lipo were removed. A micro deans connector was soldered directly to the lipo tabs (using aluminum solder flux) and the balance lead was replaced with a single pin connecter between the two cells. A special charge lead allows balance charging using the positive and negative leads from the lipo and the single pin connector.







While these changes might seem needlessly aggressive, each gram removed represents 1% of the flying weight. 1% on an F3A plane represents 50 grams, almost 2 ounces. The angle of attack an F3P foamy flies at is visually different to a trained eye with as little as a 2% change in weight. Downlines are significantly affected by weight as well.

Limiting downline speed is a substantial challenge with F3P planes. The "easy" part is motor/prop selection. In general, higher RPM motors using larger diameter flatter pitch props are preferred. PT Models makes a good selection of efficient low pitch props that have the added bonus of being light and quite durable. In addition to braking from the prop, many F3P planes utilize various types of drag brakes to limit top end speed and decrease downline speed.

The challenge with drag brakes is the smaller power systems do not have an excess of thrust. Too much drag can dramatically reduce flight times. Matching the size of drag brakes versus available power versus flightime is a bit of a balancing act. Too much drag shortens flight time leading to a larger lipo which is more weight which increases flight speeds.

The Clik utilizes very simple flat pieces of foam glued to the trailing edges of the control surfaces. While effective at creating drag, it also reduces the effectiveness of the control surfaces, which in turn requires larger control deflections which further increases drag during maneuvers. Hence, the only aerodynamic modification I made to the Clik was removing the stock air brakes in favor of a more efficient design.

The current day preferred angled split drag brake style was first seen on the Devin McGrath designed Anubis in 2010. Typically used on the ailerons, the design of the brake is such that the drag of the brake decreases as the deflection of the control surface increases. Looking at the right aileron, when right roll input is given, the frontal area of the top brake decreases as the aileron deflection increases. The bottom brake increasingly is hidden in the "shadow" of the deflected aileron. The result is increased drag in straight lines while retaining efficiency during maneuvering.

And the next step? The next step is a bit of a return to the UMX Yak. Airframe construction consists of a skeletal framework covered with mylar. However, the skeletal becomes minimal, power systems are highly geared counter rotating using foam composite propellers, and ever lighter electronic components and wiring are used. Framework options include carbon fiber rods/tubes, or balsa sticks, or foam strips covered with mylar. Carbon varieties use 0.010" and 0.020" carbon rods with limited amounts of 0.030" carbon tube. Balsa varieties use 1/32 (0.030)" square sticks (4 – 8 lb/cubic foot density) with boron and carbon fiber reinforcements. Foam varieties are full sheets of 3mm depron with large windows removed (leaving about 10% framework) and carbon fiber reinforcements.

Counter rotating propeller systems weigh 9-16 grams including the weight of the motor, mount, and 2 propellers as large as 18". ESCs and receivers weigh well under 1 gram each, and programmable digital servos are less than 2 grams each (heavily modified). Lipos as small as 1s120 provide as much as 10 minutes of flight time and plug directly into the ESC for maximum efficiency. Flying weights of less than 40 grams have become common for planes with 12" fuse height at the canopy, 44" long, and 34" span.

Several pictures are included of my Victory ISL which weighs in at 41 grams. At such a lightweight, storage and transport becomes challenging. The Victory lives in the storage crate, and only ventures out for flying sessions and maintenance.