

OVERVIEW

If you are like me, you want to spend more time flying and less time building and repairing. I fly aggressively and take lots of risks which sometimes result in the need of a repair or two. My colleague, Bill Hatcher, is an excellent builder and repairer, so that allows me to take more chances than just about anyone. If you don't have a full time staff to build and repair your planes, I feel sorry for you, but, I can give you some tips to keep your plane from needing repairs due to mechanical failures and pilot errors.

Performance and reliability are typically opposite of one another. I always push for the highest performance possible, definitely at the expense of building time and sometimes even at the expense of reliability. You make the call as to how much time you want to spend in the shop building and repairing vs. flying. I'll just present you with my observations over the years. The following is brief. On other pages on the website you will find more specific information.

Aerobatic Plane Setup

This video shows our 67" Magic Hand YAK. I go through the basics of setting up the control throws on an aerobatic plane. I use degrees of deflection rather than inches of deflection because when using degrees, there is no difference between a 5" wingspan plane or a 500" wingspan plane. These are the steps to follow:

- 1) Put on the correct size servo arms. They must be long enough to obtain the maximum throw for your size airplane. The servo arm page has more detail. This 67" Yak needs 1" servo arms on the ailerons and elevators and 3" arm for the rudder.
- 2) Set the endpoints in your radio to their maximum. With JR, the end point adjust can go as high as 150% but I find that the servo stops moving at 140% so I only set the radio to 140% of maximum.
- 3) Next determine how where to have the horn so that you get maximum throw. Maximum throw is when the control surface binds or contacts something and it can't physically go much further without straining the servo. For 3D flying the maximum movement of the control surface is the goal. If you are not going to fly 3D, DO NOT set up for maximum throw. Use the manufacturer's recommendations.
- 4) Using a throw meter, set up the aileron and elevator throws to be the same for the left and the right, up and down.

TYPICAL THROWS FOR AEROBATICS

Typically the set up for an aerobatic plane on **LOW RATES** is as follows. If you are not going to do 3D, then these would be your only rates for aileron and elevator. Rudder should be on a 2 position switch.

Ailerons up and down 15 degrees, 20 degrees would be a very high roll rate. Pattern planes use only 10 degrees.

Elevators up 10 degrees, and down 12 degrees. Keep in mind that if your plane is nose heavy you might not have enough elevator to land at a slow speed so get your CG correct. You will probably need more down elevator than up elevator because when you roll to inverted the nose will drop and you will need 2 degrees of down elevator to fly level. If you started with 12 degrees of down elevator and you used 2 degrees to get back to level, then you have 10 degrees left to use. You should be able to make just a little bit too tight of a loop either upright or inverted. Adjust the throw after flying the plane so that when you push or you pull at maximum that the loops are about the same diameter. You want a little more elevator than is necessary to make a nice loop in case you need to make a correction because you were too late with the elevator or you are flying downwind. Flying the downwind part of the loop requires more elevator than flying the upwind part of the loop.

Rudder left and right at as much as possible on high rate. You need lots of rudder for hammerheads, but for normal flying set up low rate to do a little more than knife edge flight. Keep in mind that due to the amount of right thrust in the engine that the measured deflection required for a little more than knife edge flight will be different from right to left. So if you wind up with 18 degrees of deflection to the right and 25 degrees to the left, don't be surprised. You are setting the rudder up on low rate with a little more than knife edge flight so that if you are late with the rudder and you are dropping a little that you can correct back up to level.

TYPICAL EXPO FOR AEROBATIC PLANES

There are many options though my suggestions follow. Keep in mind that I use JR so the percentages will be different for Futaba, Hitec and others. What you are shooting for is being able to fly on low rate or high rate with the same feeling with little stick movement. This way you can fly around to where you want to do 3D on high rate without the plane being overly twitchy.

Ailerons, Elevators and Rudder on low rate I use 30% expo which isn't much, just enough to soften the middle some. On high rate I use 70%. Now when I move the stick just a little, it feels the same on low and on high rate.

AIRFRAME

The *soul* of the airplane. After years of experimenting I know where to save weight in an airframe and where not to. So do some manufacturers. It may look like you can remove some wood somewhere to save weight, but typically the little bit of wood you take out weighs almost nothing and it can seriously weaken the plane, so leave it alone. Look for the lightest airframe from the factory! Lightening a heavy airframe is good, but lightening a light airframe is great!

ENGINE

The *heart* of the airplane. An unreliable engine is very annoying, and should it fail at the wrong time, it could be disaster. [DA engines](#) are the most reliable. [ZDZ engines](#) are far improved now and they are the best choice when a DA is not available like in the 80cc or 200cc size. While I have put up with my BME 110 Extreme to save weight, it doesn't have the power of a DA-100, I seized it twice due to overheating due to the small cooling fins during hard 3D flight, and the tech support is atrocious. 3W engines are hit and miss, but usually pretty good. Some are perfect and some have problems continuously. You really have to get the best, there's not much difference in price anyway.

POWER SYSTEM

The *blood* of the airplane. It is imperative that the blood flow is uninterrupted! I take the time to solder wires together instead of using 2 or 3 extensions. I don't have excess wire, I cut it off. I eliminate plugs wherever possible because they can break, not have a good connection, or cause interference. There are many fancy systems on the market like [Power Expanders](#) which make it easier for you to set up your receiver, reduce interference, and provide more power to your servos. While very useful in 150cc size planes, they are nice to have in 25% - 35% planes, but certainly not necessary. Keep the servo extensions neat. You didn't have to make the outside of the plane look good because you paid a teenage girl in China \$0.30 an hour to cover the plane for you, so you can at least make the inside look halfway decent. Battery technology is changing all the time. For the latest, check the battery overview page. What you need is to look at the complete system of batteries, chargers, plugs, switches, regulators, receivers, power distributions systems, battery balancers and more.

SERVOS

The *muscles* of the airplane. You need enough muscle to fly the way you want to fly. If you're going to putz around the sky, then [HS-5645](#) servos are OK. If you want eye popping performance then you need [HS-7985](#), [HS-7955](#), [JR-8611A](#), [8711](#), or [Seiko servos](#), and lots of them. If you fly hard and fast, you really can't have too much power. You can make a 50 lb aerobatic plane fly like a 14 oz foamie plane with the right parts! You must use metal gear servos on the control surfaces. New servos are coming out all the time. We try our best to have the latest and greatest.

HARDWARE

The *tendons* of the airplane. Strong muscles are great, but they need the proper attachments. [Aluminum servo arms](#), [titanium control rods](#), [steel horns](#), [proven clevises](#), and lots and lots of Loctite are imperative. If any of these parts fail, you are in serious trouble. Never use plastic servo arms except for the Seiko, throttle or choke servos.

ACCESSORIES

If you're not going to lighten the airframe, then all that's left is the accessories. Lightweight accessories will save about 10-15% of the overall weight of the plane, so in a 15 pound plane you can save 1.5 to 2.25 pounds by using lightweight accessories. Replacing aluminum parts with carbon fiber parts is the safest way to save weight. CF parts can break instead of bending like aluminum if you have an accident like a hard landing, so be prepared to replace some parts if you mess up. See the "[lightweight planes](#)" page for more info. Most ARF's come with aluminum parts in the kits. They have to provide some parts like a wing tube, landing gear, etc., but they are often the cheapest part they can find. If a kit includes the CF parts, then they are really putting some faith in you as a customer to understand that the CF parts are better and that you are willing to pay for them. CF parts are a lot more expensive than aluminum, so the price of their kit has to be higher. The uneducated consumer who buys on price only will not buy the higher priced kit even though it's better. If you do decide to lighten the plane with lightweight parts, 1) do it from the beginning so that you buy the parts only once and are not replacing the heavy parts later, and 2) either do all the parts or none of the parts because changing a part or two will only save a little weight while changing all the parts will actually make a difference.

PROPELLORS

Use a smaller [propeller](#) to break in the engine to keep the load down to prevent overheating. Once broken in, then the question is whether to put on a larger prop and if so, which one. If you want 3D power, then use a smaller prop, if you want smooth aerobatic flying use a larger diameter and lower pitch, if you want higher speed use the same diameter but higher pitch. Be sure to read how to tighten the propeller properly (on the propeller page). We use 16" pitch props on Warbirds to go 170 mph, we use 8" pitch props on aerobatic planes which go only 70 mph. Wood props are much less expensive than CF props though they wear out much faster. Wood props break easier than CF and this is good and bad. It's easier to replace a wood prop than a crankshaft which may bend due to the strength of the CF.

ENGINE BREAK-IN

Use a smaller [propeller](#) for the first several flights. When the engine is new the ring is not seated to the cylinder. As it seats the friction is higher, so the heat the engine generates is higher, and the power and rpm it transfers to the propeller is less. It is imperative to keep the engine more lightly loaded to prevent overheating. Also, use a petroleum based oil for break-in. This oil is not as good as synthetic, and thus allows more friction which helps the ring seat to the cylinder. You will notice dark residue coming from the exhaust, this is a combination of oil and metal. This will clear up as the engine breaks in. When the engine gains 400 rpm on the ground, the engine is broken-in, and you can decide to make a switch in props. Most people use a wooden prop for break in and then they may move into CF. We offer very good quality wooden TBM props which are the lowest priced propellers in the world.

ENGINE BAFFLES

You should baffle all engines. A very simple piece of 3/32" balsa, or thin ply should be glassed in place to prevent the air from entering the cowl and completely bypassing the cylinders. This will keep the engine cooler by 50 to 100 degrees F. It doesn't have to be perfect to work well. It shouldn't take more than an hour to install.

ENGINE KILL SWITCHES

You must have a way of killing the engine from the transmitter and from the plane. With electronic ignitions, a simple on/off switch on the plane works well as a kill switch. From the transmitter, you must be able to kill the engine from the throttle trim switch or "idle up" type switch. Many people also use an optical kill switch which is on a transmitter switch which cuts the power to the ignition. We offer the best one (which is also the least expensive) from Smart-Fly.

ENGINE OIL

There are many opinions on this. Here's mine. Use petroleum based oil for break-in. I use Pennzoil Air Cooled Oil which I purchase at local automotive parts stores. After break-in, most anything anyone suggests will work. Either continue to use the Pennzoil, or use a synthetic. I have used Amsoil 100:1 in my DA engines with great success, though it seized my BME. BME recommends Pennzoil all the time, and I agree. The ratio of oil to gas is pretty low compared to the oil used in glow fuel, so getting oil on your plane is not much of an issue.

LOCTITE

The engines and planes are very light, so they shake a lot. [Loctite](#) every screw on the plane, because if any screw falls out, it could be costly. This includes the center screws in servos, swivel clevis and horns, engine bolts, spinner screws which go in from the side, not the center bolts, the propeller bolts, wheelcollars, etc.

PREFLIGHT

Always check the following before each and ever flight:

- both battery systems are working on the receiver, turn them on one at a time to see.
- battery voltages are good
- control surfaces still work
- wing sheeting is not breaking. If you fly hard the wings will start to break at the wing tube or the leading edge.

- pull or push the prop before flipping it to start it to make sure the firewall isn't coming out, or the engine bolts are loose.

IN FLIGHT CLUES

While you are flying, if you notice any of these symptoms, there may be something going wrong. Make an emergency landing, which means cut the power and land as quickly, yet as safely as possible. Be calm, don't put it down hard, because you may be mistaken and there may not be a problem at all. Other than the obvious like a wing coming off or flutter here are some more subtle clues that something is wrong:

- roll rate or snap rate is slower than usual (batteries/servos)
- engine lacks power, especially in uplines (too lean)
- while in a 3D maneuver with the engine at full throttle, the engine dies momentarily (overheating)
- control surface flutter

On more than the rare occasion a wing will break off. There is a video of Bill Hampel safely landing his plane on knife edge with one wing, and I have heard many other similar stories. If your wing comes off, be prepared and be like Bill! Go to knife edge and fly it to safety.

ANTENNA

Keep the antenna away from other wires. Ground check. The new 2.4 Ghz transmitters have proven to be very solid performers and have only 1" antennas. Check them out!

FAILSAFE

Be sure to set the failsafe for low throttle and all other servos to hold their last position.

PCM vs FM or PPM

PCM. Though if you can go to 2.4 Mhz, then this is my preference.

INTERFERENCE PROBLEMS

If you can repeat the interference problem on the ground then you are in good shape, if not, it's not so easy to fix. If the problem is seen on the ground, make the interference happen, then first start moving the antenna. If that doesn't fix the problem, then start disconnecting one servo lead at a time, reinstalling that lead as you move to the next lead. Usually you will find the problem is coming in from one of the leads. It's usually the servo, extension or plug, but it could be that a servo lead is too close to the ignition battery, ignition switch, ignition, etc. Other likely problems

are "Y" harnesses (especially reversing "Y" harnesses), kill switches, matchboxes, the transmitter module or transmitter, the receiver crystal or receiver, metal parts vibrating against one another, CF reinforcement in fuselages, etc.

We offer JR brand RF Filters. I used these successfully on my P-40 because the throttle and choke servos were very close to the DA-85 ignition, and they were picking up stray signals and sending them in to the Rx. The interesting part was that even though I unplugged the choke and throttle servos, I still had the interference until I moved the servo wires away from the Rx. Just unplugging them didn't help! I have also had interference on one of two Rx's due to a faulty servo extension, and that interference caused interference issues on the other Rx as well. Be on the look out for interference to jump from one wire to another.