Basic Rubber Management for Science Olympiad Flight

Rubber motors appear simple, but there is a lot of science to selecting and winding your rubber motors. Successful flyers take into account many variables during selecting, tying, winding, and managing their motors. This document outlines basic techniques to help improve your approach to rubber motor management. Advanced techniques will be in another document.

Improving rubber selection and assembly

- **Rubber Sourcing**. All of our rubber currently comes in bulk from FAI Model Supply in stock sizes. Several vendors, such as Indoor Free Flight Supply, J&H Aerospace, and Freedom Flight Models will custom cut rubber width.
- **Rubber sizing**. For the current kits (2024), the 3/32" stock rubber may be close to what is needed. While you can purchase a rubber stripper to cut your own widths, it is likely more cost effective to buy custom stripped rubber
- **O-rings**. Rubber or nylon O-rings on the rubber make it easier to transfer the rubber from the winder to the airplane. These are included in the rubber mass, so decrease your available mass by about 0.08g, but it is difficult to work with the wound rubber without these o-rings. These O-rings are a good choice. Use of O-rings is shown around 1:00
- **Rubber Tying**. The rubber is like a gas tank. The more rubber you have, the more gas in the tank. Therefore, it is important for performance and consistency to tie rubber loops very close to the maximum allowable mass, 1.5g in 2024. Tying rubber motors is demonstrated in the first 2:40 of this video. The video shows the use of hemostats, available on Amazon for a few dollars. Without hemostats, you can use pliers or vice grips, with the help of a partner to hold the pliers closed. **Always lubricate the portion of the rubber where you are tying the knot** to prevent damage to the rubber. You can use water or saliva, as silicon lube in the knot may make it harder to tighten the knot.
- **Mass**. Be sure your scale is accurate. Trim the untied rubber until right at 1.5g. Don't guess! Then tie it with minimal rubber in the hemostats or pliers.
- **Mass Adjustment**. If you get to the event and your rubber loop is over weight, adjustment is simple. First, make sure the lube is wiped off the rubber. Second, if it is slightly over, ball it up and breath on it to relieve static electricity and try again. IF still overweight, trim it as follows: Tie an overhand knot in the loop, and slide it down very close to the existing know. Tie a second overhand knot and slide it down tightly against the first. Then cut off the original knot, and you have reduced the mass by 10-20mg.
- **Lube**. The rubber should always be lubricated when winding. You can purchase a silicon based lube at FAI Model Supply or IFFS, use silicon shock oil for R/C cars, or use Original Armor All or Son of a Gun, available at auto parts stores. Put a small amount is a zip lock baggie, drop the rubber in and squish it around to fully coat it. Wipe any excess off, it should not be dripping.
- **Keep the rubber clean**. The lube may attract dirt from the floor when the plane lands. This dirt can tear the rubber if left on while winding. After each flight wipe down the rubber with a paper towel to remove any dirt.

Improving flight consistency

- **Variation and Grading**. Rubber varies in thickness and/or density due to manufacturing processes. Therefore, loops of the same mass will have different lengths, and different winding characteristics. It is important to test and compete with like pieces of rubber! Therefore it is important to grade, mark, and organize your rubber.
    - Measure the loop length of each motor after tying but before breaking it in. Record this and keep the record with the piece of rubber.
    - Record your starting loop length and loop mass in your flight log
    - Keep the record with each piece of rubber at check-in so that you know which is which
- **How variation affects flights**. Thicker rubber (shorter loop) will not take as many turns, but will have higher torque. If too thick, the winds will run out before the flight is done. If too thin, many turns will remain on landing, which does not effectively use the rubber mass. Adjust the rubber width by selecting a longer or shorter loop based on flight data.
- **Re-using rubber**. Each flight you use the rubber, it permanently stretches slightly. This occurs most on the first wind. Understand that a well-used piece of rubber will act like a longer loop, with lower power but more winds. It will pay to record how many flights a piece of rubber has on it so that proper selection for competition may be made. Testing with old tired rubber, but then competing with new loops, may give entirely different flight results.
- **Break in**. Since much of the stretching occurs on the first wind, it is important to "break in" your motors. Most will wind to 80-90% of max winds, hold for a minute, and then dewind without flying to break in the rubber.
- **Max Turns**. You can determine the maximum turns your rubber can tolerate by breaking some samples. However, there is a calculator available to estimate the max turns capability of your rubber. It can be found on the flying tab of the NFFS SO website.
- **Wind off your plane**. Winding on the plane risks damage to the plane if the rubber breaks during winding. It also allows more consistent winding, even if a torque meter is not used. Make a simple stooge with a wire hook to hold one o-ring, and put the other o-ring on your winder.
- **Stretch Winding**. As you wind, the rubber forms knots. Each know holds a bit of your rubber loop, and that rubber can no longer twist. By stretching the rubber as you wind, you can delay the formation of knots and therefore get far more winds into your motor. Stretch the rubber 5-8 times the original loop length. Wind 60% of the target winds at full stretch, then start to walk in while continuing to wind. Stop once the stooge-to-winder distance matches your plane's hook-to-hook distance. Coach Brian's video demonstrates basic stretch winding technique.
- **Torque Meter**. The torque meter helps you to monitor the winding of the motor and maximize the winds in the motor. Motor capacity is limited more by torque rather than winds, especially as the motor gets used multiple times. While a torque meter is not strictly required, it does provide information that is valuable for maximizing rubber motor performance. A simple torque meter is shown in this video. While some may consider a torque meter "advanced" , it is very simple to sue and provides great information, so we highly recommend it as soon as possible in your flying career.