Coaching A Successful SO Helicopter/Flight Event – Outline

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Coaching A Successful SO Helicopter/Flight Event – Content

Session Objective

In this session I will review some of the many issues that can affect team performance in the 2025-2026 Science Olympiad Helicopter Flight Event. I will discuss areas in which teams often prepare and perform less than optimally. My comments apply in general to all Science Olympiad Flight Events. They are based on my observations of participants' entries over the years. You are fortunate in that every year the amount of reference information readily available to you on the internet increases dramatically. Have your team members take advantage of them. I have provided some links in this document, but there are many other sites that can provide much better guidance than I. Start with the website of the event sponsor: National Free Flight Society (NFFS).

My Background

My name is Larry Michalowski. I am a retired electrical engineer. I have built balsa model airplanes since I was a boy. I have assisted with Science Olympiad Flight Events for over 20 years. First as a parent and coach, then as an Event Supervisor.

Elements For A Successful Event

A – Get Knowledgeable Help

1 - In my experience, teachers charged with managing Science Olympiad competitions need all the help they can get. No one teacher can successfully handle the many events, limited preparation times, and widely varied event topics involved, in addition to their normal, day-to-day teaching responsibilities. The teachers I have seen in charge of Science Olympiad teams are just that, teachers. They generally have little experience in actually building things, so additional help is especially needed for the flight/build events.

2 - Try to get assistance from parents; especially those with backgrounds in engineering, or the sciences, or are hobbyists having general experience in constructing things. Even parents with skills like carpentry or home repair/remodeling can be put to good use. Local modelers are usually happy to help and pass their skills along to interested youngsters.

B - Assign Appropriate Team Members

1 - One of the greatest constraints in Flight Events is the need to apply aerodynamic principles. They are not intuitive. Even with my engineering background, I still sometimes struggle with them. Middle- and high-school students have not had any exposure to aerodynamics. Without any frame-of-reference as

to IF or WHY their model is performing (or not performing) well, they will not know what adjustments to make.

2 - It is not always the best decision to assign the smartest team members to Flight Events. A know-it-all can bring a closed mind that does not consider all variables, even to the extent of ignoring instructions or guidance that they deem unnecessary. Try to assign students who are open to experimentation and are not easily discouraged. It can be very frustrating when attempts to adjust a model have little effect, or make it perform worse. The most extreme instances I have seen involve demoralized teams that submit poorly-built models. When asked, they tell me they didn't want to be in the event but their teacher put them there because there was no one else available or interested, and they received no assistance or support with their preparations.

C – Build Precisely

1 - The first decision the Event team needs to make is whether to build their models from scratch, or buy one of the many kits that are now available. Due to time constraints, most teams choose build from kits, as they provide all necessary construction materials and contain detailed instructions. However, kits do have some weaknesses. The balsa wood and rubber provided may not be optimal (see item C4 and Section E below). The instructions, while usually clear and detailed, stifle experimentation, which is at the heart of the scientific method espoused by Science Olympiad. Building from scratch is more thought provoking and encourages experimentation, but requires greater time and commitment.

2 - The internet now contains many resources for Science Olympiad Helicopter and Flight Events, with more coming online daily. Some sources for model kits, materials and supplies can be found among the links provided in Resources, Section G below. Many You Tube videos have been posted that provide, in great detail, excellent guidance for construction, adjustment, and flight. Encourage your team members to research the internet.

3 - It is critical that team members follow instructions carefully. Model integrity and performance require that construction steps be done exactly as described. Slight variations in dimensions or angles that are not readily obvious can affect the aerodynamics of the model, and result in poor performance that may be difficult to correct.

4 - The structural elements of models are primarily balsa wood. Balsa wood properties vary widely from piece-to-piece. Critical characteristics such as weight and density can change even within a single piece. Dense, rigid balsa is needed for body shafts to withstand the compression and flexion forces from the fully-wound rubber motor. Low-density, lightweight balsa is needed elsewhere, such as rotor spars, to minimize weight. Locating and purchasing good balsa is critical for scratch-built models. Care must also be taken when using purchased kits. I have seen kit-models with structural issues due to poor quality balsa. Check the appropriateness of kit balsa before you begin construction and contact the manufacturer if it seems inadequate.

5 - Different glues are needed during model construction. Use fresh CA (cyanoacrylate) super glue for balsa joints. Thinner is better. Use Duco cement for joints under heavy loads. Use thinned Contact Cement, or spray poster-board adhesive (or even Duco cement or a children's Glue Stick) to secure plastic film coverings to rotor spars. Glue adds weight. Use it sparingly.

6 - CA glue does not fill gaps well. For structural integrity, balsa must be in full contact at ALL joints. Do not attempt to reinforce a weak joint with additional CA glue applications. If a joint has poor wood-to-wood contact, replace the wood with another piece having a better fit.

7 - Kits usually come with enough materials to build two models. BUILD THEM BOTH. Murphy's Law applies. A model can break, or get stuck in a ceiling obstruction, at the most inopportune time. Sometimes, one of the models will perform better than the other for no apparent reason.

8 - Insist that team members carefully review their models for full compliance with all Construction Parameters, particularly with respect to the Measurement Box (see items C9 and C10 below), and their Flight Logs (see item D5 below). Some kit models are designed EXACTLY to the event rule limits. A slight error in assembly, or sloppy application of the rotor covering material, may cause the model to exceed event dimensional specifications by a few millimeters. Building a model several millimeters (or even a centimeter) undersized will not noticeably affect flight times, and will avoid the need for frantic, last-minute modifications during Event Check-In.

9 - Each team must provide their own Measurement Box. The OUTSIDE DIMENSIONS of this box MUST FIT ENTIRELY WITHIN the right, rectangular prism specified by the rules. Procuring or constructing a suitable Measurement Box is nearly as important as building a good model. As an Event Supervisor, this is the rule compliance with which I have had the most difficulty. I have seen Measurement Boxes that were unevenly cut so part of the Box extends beyond the prism; or constructed of several segments so poorly secured that they do not hold a shape that stays within the prism. NOTE: The Measurement Box itself does not need to be a right, rectangular prism.

10 - The fully-assembled model(s) MUST FIT COMPLETELY WITHIN the Measurement Box. I have seen teams use a Measurement Box that is smaller than the right, rectangular prism limits, with the result that their model does NOT fit entirely within their Box, even though it would otherwise comply with the Construction Parameters.

D – Trim Carefully

1 - All models need to be adjusted (trimmed) to improve their performance; and sometimes even to perform at all. Follow trim instructions provided with the kit or found online.

2- Make adjustments in SMALL INCREMENTS. This is CRITICAL. Even adjustments almost too small to see can sometimes radically alter a models' flight. There are many possible adjustments, and multiple adjustments are often required. Sometimes one adjustment cancels out another. This is one of the most frustrating parts of modelling for students, and can be a challenge even for experienced modelers.

3 - Trimming is needed to balance the strong, competing aerodynamic forces being exerted on the model during flight: Lift, Weight, Thrust and Drag. If these forces become even slightly unbalanced, the effects can cascade catastrophically. Students might benefit from a review of the principles of flight, upon which the rules of aerodynamics are based. (See links in Resources, Section G below).

4 - Expect every model to be damaged at some point. They are made of as little material as possible to reduce weight. They are fragile. Balsa wood fractures easily. It is a rare model that never needs repair. Repairs usually involve straightening and gluing a broken piece of balsa. Unfortunately, a repair generally does not return the model exactly to its' previous configuration. The balsa alignment may be slightly different, affecting the rotor lift. The added glue changes the balance slightly. These changes, while small, may be enough to affect aerodynamic forces. After each repair, further trimming adjustments MUST be made to assure flight performance has not degraded. I have seen seemingly minor damage result in significant reduction in flight performance. If a part of the model is repeatedly damaged, requiring multiple repairs, and performance is being affected, replacing the broken part (or even the entire model) may be called for.

5 - Flight Logs are required and add an easy bonus to a team's score. Unfortunately, in my experience, many teams do not put sufficient effort into their Logs. The Logs must contain data for three specified flight parameters. They must ALSO contain data for three ADDITIONAL flight parameters of the team's choosing. The additional parameters chosen MUST relate to flight performance. Event Supervisors may disallow a parameter that does not appear to relate to flight performance (e.g.: the name or color of the model flown). Flight Logs MUST indicate units of measurement for EACH parameter (except "arbitrary" torque numbers – see NOTE 2, below). Insist that team members review their Flight Log for compliance with all rules. Event Supervisors will confirm that sufficient data is recorded for ALL SIX parameters. They will question team members about their data, how model performance changed as a result of their adjustments, and their conclusions, to assess whether they were conducting scientific experiments with flight. In better Logs, comments are added regarding the effects of trim changes. Make sure team members are able to answer questions about ANY entries in their Flight Log. Most kits include a sample Flight Log data entry sheet, but any spreadsheet-style dataset is acceptable. Avoid narrative-style Flight Logs, which make it difficult to confirm that all required parameters and data are recorded. NOTE 1: Only ONE Flight Log is required for each team (NOT one per helicopter). NOTE 2: If motor torque is chosen as one of the additional parameters, and units of torque are specified (instead of "arbitrary" numbers), team members may be questioned about the torque units specified and how they were obtained. I have found that most students are not able to clearly answer questions about torque measurements.

E – Wind Rubber Motors Optimally

1 - Competition model motor rubber is specially formulated. TAN Super Sport is the gold standard. If your team wants top performance, they MUST use this brand of rubber. Only purchase kits that include this brand. I highly recommend buying additional rubber separately, as it deteriorates with use and you

should expect that some motors will break during winding. It can be purchased from FAI Model Supply and other secondary suppliers. (See links under Resources, Section G below).

2 - Motor rubber comes in several standard widths. Kits only provide the standard width most likely to perform well with that particular model. However, performing well is not the same as performing optimally. The rubber motor powers the helicopter rotors. The rotor parameters (dimensions, pitch and weight) resist the wound motor. Wider rubber applies greater force (torque) and can turn rotors faster, taking the helicopter higher, but they accept fewer winds so the rotors stop turning sooner. Narrower rubber applies less force, but accepts more winds and the rotors turn longer. For best performance, teams must experiment to obtain the MOTOR SIZE that gets their helicopter to the ceiling and has it stay there the longest. This is complicated by the fact that competitions are held in different venues, each with a different ceiling height. A motor that is optimal at a lower ceiling height may not be so for a higher ceiling. (That's why the Event Rules require that Tournament officials must announce room ceiling height prior to the competition.) The performance of each model will be unique so experimentation is critical. By MOTOR SIZE I mean the motor weight, which is a combination of rubber width and length. Teams can cut their motor rubber to any desired length. There are no Event Rules limiting the rubber motor weight, so the heaviest (i.e.: longest) motors (usually) perform better. Heavier motors will accept more winds and so power the rotors longer. NOTE 1: The knots tying motor rubber into loops must be made very carefully so they do not become undone when the motor is fully wound. There are tutorials and videos demonstrating proper knot-tying. (See links under Resources, Section G below). NOTE 2: For truly top performance, teams may wish to consider purchasing a rubber stripper to obtain rubber motors having non-standard widths. Such motors may yield better performance than do those of the next-wider/-narrower standard widths.

3 - Rubber motors do not load (store energy that is converted to torque) linearly as they are wound. Initial winds will impart little energy, and so yield little torque. After some number of winds, the loading becomes linear. As the number of winds approach the maximum the motor will bear before breaking, the load (available torque) increases rapidly. The teams' objective should be to impart as much energy into the motor as possible. This is done by maximizing the number of motor winds. However, due to material and production variations, and as the motor fatigues from repeated windings, each individual motor size accepts a different number of winds before breaking. The only way to obtain an estimate of when a rubber motor is approaching the maximum number of winds it will accept is by using a Torque Meter. There are many You Tube videos that show how to wind a rubber motor using a Torque Meter. Have the team members learn from them. Torque Meters can be purchased from various suppliers.

4 - Rubber motors should be lubricated before winding. Lubrication reduces friction between the rubber strands, allowing for many more winds. Rubber motor lubricants can be purchased from model suppliers. Research household lubricants carefully. Use only silicone-based lubricants. Petroleum-based lubricants will cause rubber deterioration and premature breaking. Threading small rubber o-rings onto the rubber motor before tying makes it easier to remove the wound motor from the Torque Meter and Winder and attach it to the model. These o-rings are often provided in kits and are also available from suppliers.

5 - Rubber motors should be stretched (a lot!) during winding. Stretching results in the turns being arranged evenly along the rubber, leaving room for many more turns and avoiding bulging snarls that may snag on the helicopter body and interfere with steady rotation during flight. There are many You Tube videos available that demonstrate good winding technique.

6 - Team members must gain experience in motor winding to get a feel for how tightly a motor can be wound before it breaks. This can only be done by breaking a motor occasionally. They must watch the Torque Meter dial carefully while winding and note the dial number or position if/when a motor breaks. The breaking number/position on the Torque Meter should be similar for all their other motors of that size. In my Event Supervisor questions, I often ask whether a team has broken any motors while winding. I have found that teams which have not broken any of their motors never have the longest flight times. Their model may fly well, but it invariably comes down sooner than it might have, had they learned how to get more winds into their motors. NOTE: ONLY wind a motor while it is connected to a Torque Meter or Winding Stooge. NEVER wind a motor while it is connected to the model - If the motor breaks, or the winder slips from the team members' hands, the model will likely be destroyed.

F – Focus During Competition

1 - Balsa models are very fragile. Store them in a cushioned travelling container, or the Measurement Box, when not in use. When in use, team members must constantly be alert to their surroundings; particularly when others are nearby and likely not paying attention. I have seen models broken by: (1) an onlooker quickly turning and walking into a team member they didn't see who was carrying a model, or (2) a team member doing the same with a nearby onlooker.

2 - Make sure that the team brings ALL needed materials and supplies to the Event Check-In. Encourage good housekeeping habits that keep EVERYTHING needed for the event stored together. That includes any glues, tools and replacement parts needed to repair a model that becomes damaged after the team enters the cordoned-off competition area. I have lost count of the number of teams that have arrived at Event Check-In without critical elements such as their Flight Log or Measurement Box (or even both team members). There are often many teams competing, so it cannot be guaranteed that a team will be allowed to compete if they are unable to check in during their assigned Flight Period because they do not have all the necessary materials with them. Travel distances to school homerooms are often too great for an individual to get a missing item and return in time.

3 - Event Check-In is hectic. Often, several teams are being processed at the same time. Team members are nervous and distracted. Remind them that they need to pay attention to Event Officials, and to promptly follow all instructions, and answer any questions. The competition area is often noisy. Instruct them to speak loudly and distinctly. Many Event Supervisors (including me) are hearing challenged.

4 - Check in TWO models, and as many rubber motors they think might be needed for all flights. Only checked-in motors may be used. Have them include spares in case some motors break during winding.

5 - When preparing to launch, the team member should examine the competition area and try to envision where the model will fly. They should position themselves so as to launch where the model is not likely to fly into any ceiling or wall obstructions, or other models that are in flight. Every year I see at least one individual who will launch in the corner of a room, or right next to where they were winding, when other, more open and unobstructed areas were available, because they didn't look first.

6 – Each team is allowed two official flights, and as many practice flights as they wish, within their 10-minute official Flight Period. Get team members into the habit of multitasking. When a flight is launched (either practice or official) one (or even both) of the team members should get busy winding another motor or preparing the other model, so as to be ready to launch another flight (either practice or official) as soon as the first one ends. If the first model is damaged during its flight, they must be prepared to decide whether the other model should be used for the next flight, or whether they should try to repair the first one in time to launch another flight before their official Flight Period ends. Have them practice such last-minute-decision scenarios. If a problem arises during competition, in their minds their 10-minute Flight Period will suddenly seem like only 10 seconds. I have seen teams that encounter a problem freeze, unable to decide the best way to proceed in order to make best use of the limited time remaining to them. A team working to recover from a problem may ask their Event Timers to provide occasional updates on the time remaining in their official Flight Period.

7 – Instruct team members to confirm their competition results. They should verify their official flight times and clearly understand (asking questions if necessary) whether and why they received any bonuses or penalties. Appeals are filed by a parent or coach who likely was not present during the actual scoring. The wording of an appeal is usually based on the explanation received from a team member, so it is imperative that they accurately understand, and can clearly communicate, the issues. Event Supervisors are instructed to NOT attempt to resolve appeals with students, parents or coaches. Arbitration Officials work with all involved individuals to address appeals.

G - Resources

1 - National Free Flight Society (NFFS)

https://www.freeflight.org/science-olympiad/
https://www.freeflight.org/wp-content/uploads/2024/09/Basic-Helicopter-Build-9-5-24.pdf
https://www.freeflight.org/Library/TechLibrary/

2 - Science Olympiad Student Center

https://scioly.org/wiki/Helicopter

3 - Principles of Flight

https://pilotinstitute.com/principles-of-flight/
https://calaero.edu/aeronautics/aerodynamics/airplane-aerodynamics/
https://www.faa.gov/sites/faa.gov/files/07_phak_ch5_0.pdf

4 - Balsa Grain Classification

https://specializedbalsa.com/balsa_grain_classification.php
https://www.freeflight.org/Library/TechLibrary/Wood%20Grain%20Analysis.pdf

5 - Rubber Motors

Rubber Motors - https://www.endlesslift.com/rubber-motors/
Making A Rubber Motor - https://www.endlesslift.com/making-a-rubber-motor/
Tying a Knot - https://www.stickandtissue.com/forum/cgi-bin/yabb2/YaBB.pl?num=1689466829
Sizing Rubber Motors - https://www.freeflight.org/Library/TechLibrary/RubberMotorSizing.pdf
Custom Cut TAN Rubber - https://www.indoorffsupply.com/shop/custom-cut-tan-super-sport-rubber-25ft

6 - Supplies

FAI Model Supply - https://www.faimodelsupply.com/
Indoor Free Flight Supply - https://www.indoorffsupply.com/shop