

1. DESCRIPTION: Teams will construct and test up to two electric motor powered monoplanes with a single propeller assembly to achieve maximum flight times. Energy to the motor is provided by a capacitor.

CAUTION: Capacitors store energy. Damage to the capacitor and/or a sudden release of energy may result if it is charged from a device or circuit other than as specified in these rules.

A TEAM OF UP TO: 2

IMPOUND: NO

TIME: 8 minutes

2. CONSTRUCTION PARAMETERS: All airplanes must meet the following specifications:
 - (a) Airplanes must be constructed prior to the tournament.
 - (b) Only wood, paper, wire, thread, plastic, plastic film covering, carbon fiber, tape and glue may be used. The major components (wing assembly, tail assembly, fuselage, motor and capacitor) may be attached to each other using, music wire, malleable and insulated wire, paper or plastic tubes and/or rubber bands. Wing and tail assemblies may not be solid balsa. Airplanes may be constructed from published plans, commercial kits and/or a student's design. Kits may need to be altered to comply with the current specifications. Kits may not contain any pre-glued or pre-covered surfaces.
 - (c) The airplane must be a monoplane (one wing) not exceeding a maximum horizontally projected wingspan of 40.0 cm. The maximum chord of the wing is 10.0 cm (the straight-line distance from the leading edge to the trailing edge of the wing. The maximum horizontally projected span of the stabilizer is 28 cm and the maximum chord of the stabilizer is 7.0 cm.
 - (d) The electric motor and propeller must be commercially available. The propeller must be plastic and have only two blades. The propeller may be trimmed, shaved, twisted or adjusted to improve performance or reduce weight. No modifications to the electric motor are allowed. For Division-C tournaments, a geared motor may be used. For Division-B tournaments, the propeller must be attached directly to the electric motor shaft. Each airplane may have only one electric motor and one propeller. The electric motor must be mounted to provide a pusher configuration to the airplane. That is, the end of the shaft to which the propeller is attached must be pointed in a direction opposite to that which the airplane flies.
 - (e) Division-C airplanes must have a landing gear with at least two wheels of 1.5-cm diameter or greater and flights must rise off the floor. Division-B airplanes may be hand-launched and do not require landing gear.
 - (f) Power for the electric motor must be supplied by a single capacitor with rated voltage of 2.3-3.0V and maximum rated capacitance of 10F. The capacitors must be commercially available and be imprinted with voltage and capacitance ratings. The motor and capacitor are electrically connected by wires. Switches and pin or terminal connectors may be used. Electrical connections may be twisted, crimped, soldered or glued.
 - (g) The total mass of each airplane including the electric motor, propeller, capacitor and landing gear (if required) shall be not less than 12.0 grams for both Div-B and Div-C.

- (h) The capacitor is to be charged directly from not more than two standard AA size Alkaline dry cell batteries, each rated a maximum of 1.5 V. The batteries may be connected in series or in parallel. Batteries are not allowed to be replaced after inspection. The charging system may not contain any other energy-storing, or any voltage-modifying, components or devices. Only one charging system is allowed per team.
- (i) Each airplane must be labeled so the Event Supervisor can easily identify the team to which it belongs.

3. THE COMPETITION:

- (a) The event must be held indoors. The room dimensions (approximate length, width and ceiling height) should be made available to teams in advance of the competition. Directors and the Event Supervisor are urged to minimize the effects of environmental factors such as air currents caused by open doors and HVAC fans.
- (b) Once teams enter the cordoned-off competition area to trim, practice or compete, team members will not receive outside assistance, materials or communication. Teams violating this rule will be ranked below all other teams. There will be a separate area for spectators.
- (c) Each team must present for inspection a flight log of data recorded for 6 or more parameters and a minimum of ten flights prior to the competition. The data for at least 4 of the parameters must not be the same for every flight. Required parameters to be recorded are 1) specification (voltage and capacitance) for the capacitor used, 2) mass of airplane, and 3) time aloft. The team must choose three additional data parameters beyond those required, for example: charging time, charging batteries output measured (volts), center of gravity location, altitude gained, estimated flight diameter, propeller size (diameter and pitch), time held after motor start before launching, or others of the team's choosing.
- (d) At the Event Supervisor's discretion, practice flights may occur throughout the event but will yield to any official flight. Multiple practice flights may occur at the same time. No trim or practice flights will be permitted in the last half-hour of the event.
- (e) A self-check inspection station may be made available to teams prior to being measured by the Event Supervisor.
- (f) Team members must present their event materials (airplanes, flight log and charger) for inspection immediately prior to the team's official flights. The charger must be opened for inspection of the cells. The capacitor will be discharged by short-circuiting its leads with an appropriate conductor.
Teams with airplanes carrying coins for bonus points must remove the coins for independent checking of their mass. The coins will be re-attached after testing. After inspection, all event materials will be held in the control of the Event Supervisor until timing officials are assigned to the team.
- (g) Teams may make up to three official flights using one or two airplanes.
- (h) Teams will be given an 8-minute "Flight Period" starting with their first flight, whether for checking flight trim or official. Any flight not declared by the team as a practice flight will be timed as an official flight. Participants may make adjustments/repairs/trim changes to their airplanes during the 8 minutes, but no extra time will be allowed to make

such changes. Upon substitution of parts, the airplane must be re-checked by the Event Supervisor for compliance before flight.

- (i) The Timer will measure the time aloft for each official flight to a precision of 0.1 seconds. The Event Supervisor may allow multiple Timers and score the average of their times. Time Aloft for Division-B starts when the airplane leaves the hand of a team member. Time Aloft for Division-C starts when the airplane leaves the hand of a team member, but if the airplane is not airborne before a count of 5 seconds, a “no-flight” will be declared by the timer. That is, the attempt will not count as one of the three official flights, but will be counted as part of the 8-minute “Flight Period.” Time aloft for both Division-B and Division-C will stop if any part of the airplane touches the floor after becoming airborne or when the airplane comes to rest for one second or more due to meeting an obstruction.
 - (j) The Event Supervisor may permit other official flights during the flight of another team’s airplane once it has started its descent. In the unlikely event of a collision with another aircraft, a team may elect a re-flight. The decision to re-fly may be made after the airplane lands. The 8-minute period does not apply to such a re-flight.
4. SCORING: The winner is the team with the longest two flights (the sum of the two flight times). Ties will be broken by the longest time of the third flight.
- (a) Teams that have incomplete flight logs will have 10% of the times for the two best flights subtracted from their score.
 - (b) Teams without flight logs will have 30% of the time for their two best flights subtracted from their score.
 - (c) Teams that violate a rule under “CONSTRUCTION” or “THE COMPETITION” sections that does not have a specific penalty will be ranked after all teams that do not violate those rules (Tier II).
 - (d) Teams that receive outside assistance during the competition or official practice periods will be ranked after all other teams (Tier III).
 - (e) Bonus points: 25% of the time aloft will be added for airplanes that carry one US one-cent coin (2.5 grams) for the entire duration of a flight. A 50% bonus will be added for airplanes that carry two US one-cent coins for the entire duration of a flight. The coins may be used as part of the 12-gram mass required in part 2(g) of these rules. If an airplane lands without one or both coins, the flight will be scored for zero time and the airplane and coins must return to the Event Supervisor to re-check the mass before another flight may be scored

Rationale

E-Wright Stuff for Science Olympiad

We have run a series of tests on a new flight event using an electric motor and propeller powered by a capacitor. The rationale for using a capacitor is that the energy available is much less than in commonly used batteries to power model airplane motors. Because of the limited power, flight times are generally between one and two minutes on our test airplanes. These short flight times are well suited to the traditional format of the Wright Stuff competition where each team is given a short period of time, usually 8 minutes, to make their flights. The flight characteristics of capacitor power mimic those of rubber power. There is quite a bit of energy available at the start of flight, but it tapers off after about 20-30 seconds and the airplanes cruise back to the floor. Because the propellers are much smaller than used for rubber power, the effects of torque on flight trim is not much of a factor. Need it be said that LiPo battery power would not be suitable because of the extended flight times that they make possible would not fit into the SO tournament format?

Airplanes tested look like Indoor rubber-powered craft. To demonstrate that crude airplanes would give suitable results, a standard paper-covered Delta Dart provided flights approaching 60 seconds. Test airplanes with traditional tractor configurations as well as pusher configurations were made. The latter were tested because of safety concerns from the high rpms with small propellers and electric motors. One test with a tachometer showed a peak of 11K rpm on a 65 mm propeller.

It is quite easy to build airframes for this event that weigh in the range of 2-3 grams using techniques and skills and materials that many students have mastered for the rubber-powered Wright Stuff Event. The power train for these airplanes will add another 6-7 grams. Our experiments have showed that airplanes that weigh 10 grams or less are not suitable for most school gyms because they rapidly exceed the ceiling limitations. One approach to solve that problem was to use capacitors and motors with reduced power for typical school gyms. However, that approach would require that schools purchase a variety of capacitors and motors with resultant expenses. We found that adding dead weight (in the form of US one-cent coins) to airplanes using only the most powerful capacitors and motors was a suitable method to limit climb and still provide flight durations approaching 60 seconds in gyms with ceilings of only 6-7 meters. This led us to propose that airplanes carrying such dead weight would receive a bonus score to reward those who had developed better building skill through practice.

Consideration should be given to the comparative cost of airplanes for the E- airplanes and traditional rubber-powered airplanes. Outside of the cost of the airframe, the expense requirement for the E-airplane is well under \$20. Compare that to the cost of a half-pound of rubber strip and a winder for well over \$30. If you add the cost of a rubber stripper, micrometer and torque meter that the best teams will use, the cost factor favors the E-airplanes by a large margin. All the materials required to complete an E-airplane are commercially available. For those unfamiliar with capacitor state-of-the-art, those that were used for testing the airplanes are so-called "supercapacitors" or

“ultracapacitors” and are available via the Internet from Noodlehed Electronics. The motors and propellers are available from Plantraco, a well-known supplier of micro-RC equipment and kits. Resources for building the airframes are the same as for the Wright Stuff and Balloon Launch Glider Events.

That said, it is not our intention to replace the traditional rubber-powered Wright Stuff Event by the E-Wright Stuff Event, but to place both in the Event rotation of the Science Olympiad. Airplane events....real airplane events.... are the biggest crowd pleasers of all in the SO tournaments.

There are no unusual requirements for officials who would be running the Event. The only measurements are the mass and dimensions of the airplane. Capacitors and batteries (for charging the capacitors) are labeled.

A summary of our experimental findings is available upon request as are photos and some low-resolution video of flights.