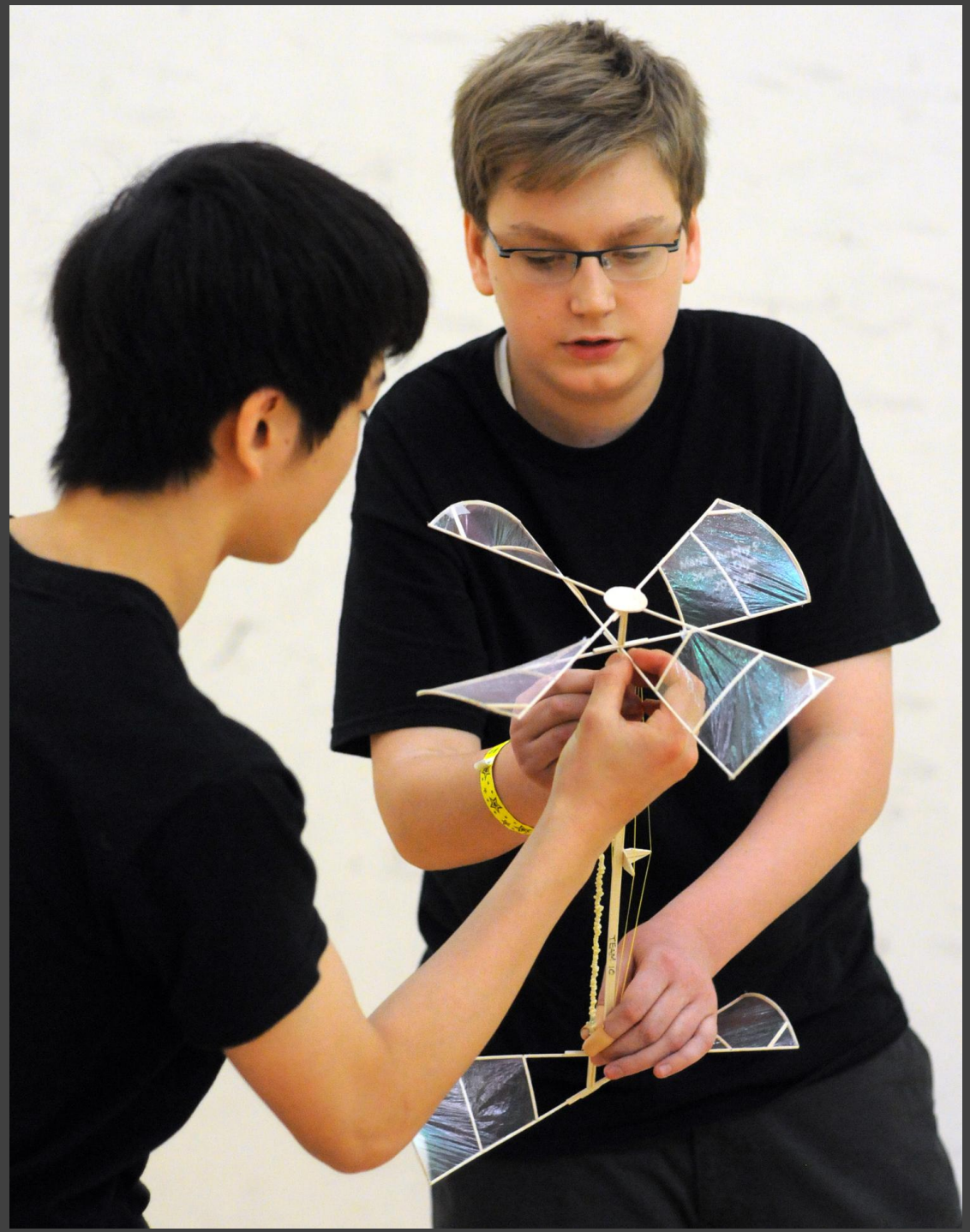
2026 Science Olympiad Helicopter Event

Slides by Chuck Andraka

NFFS Youth Development Program

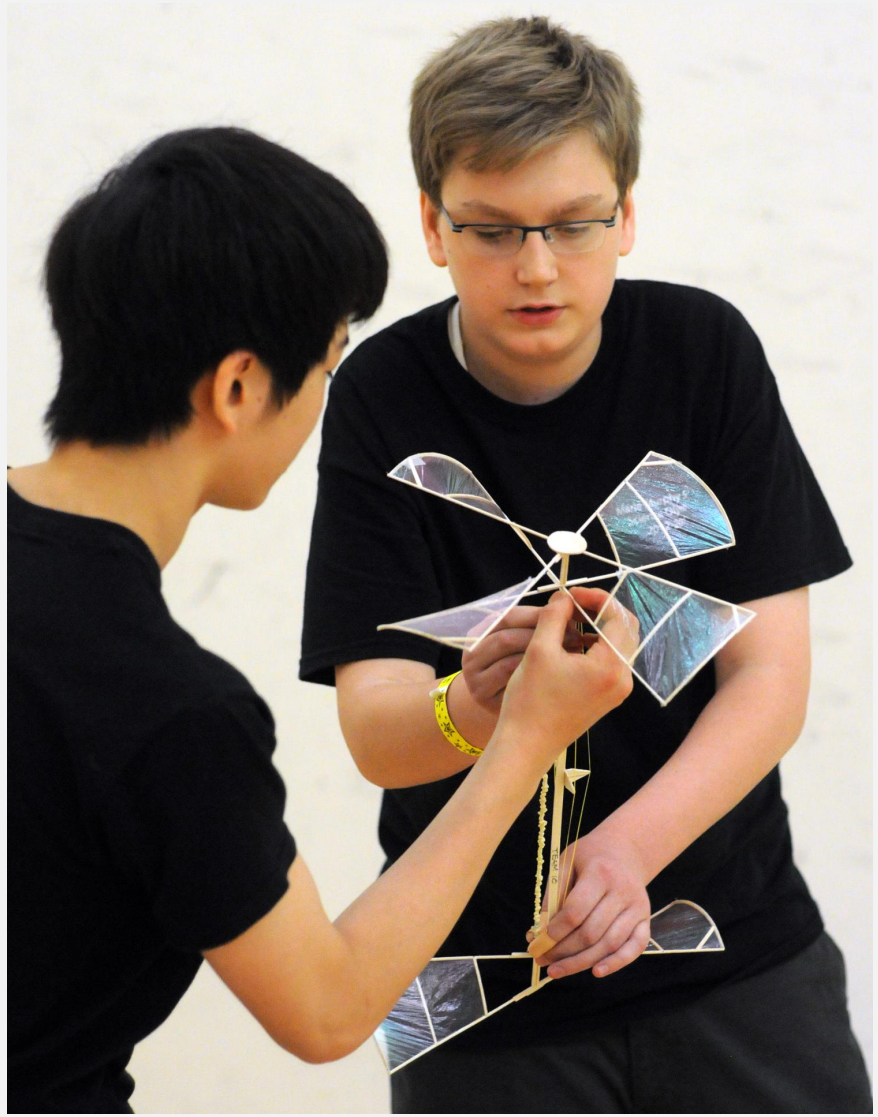


Presentation Order

- Event descriptions and rules
- Resources
- Observed issues
- Winding
- Flight Optimization

Helicopter Event Description

- Prebuild event
- Rubber Powered Indoor Helicopter flown for Duration
- Team-built Device
- **Presented in a box with outer dimensions specified**
- Best of two flights duration
- Kits are permitted
- Rule by Rule discussion in 2025 Coach's Clinic: PDF and Video



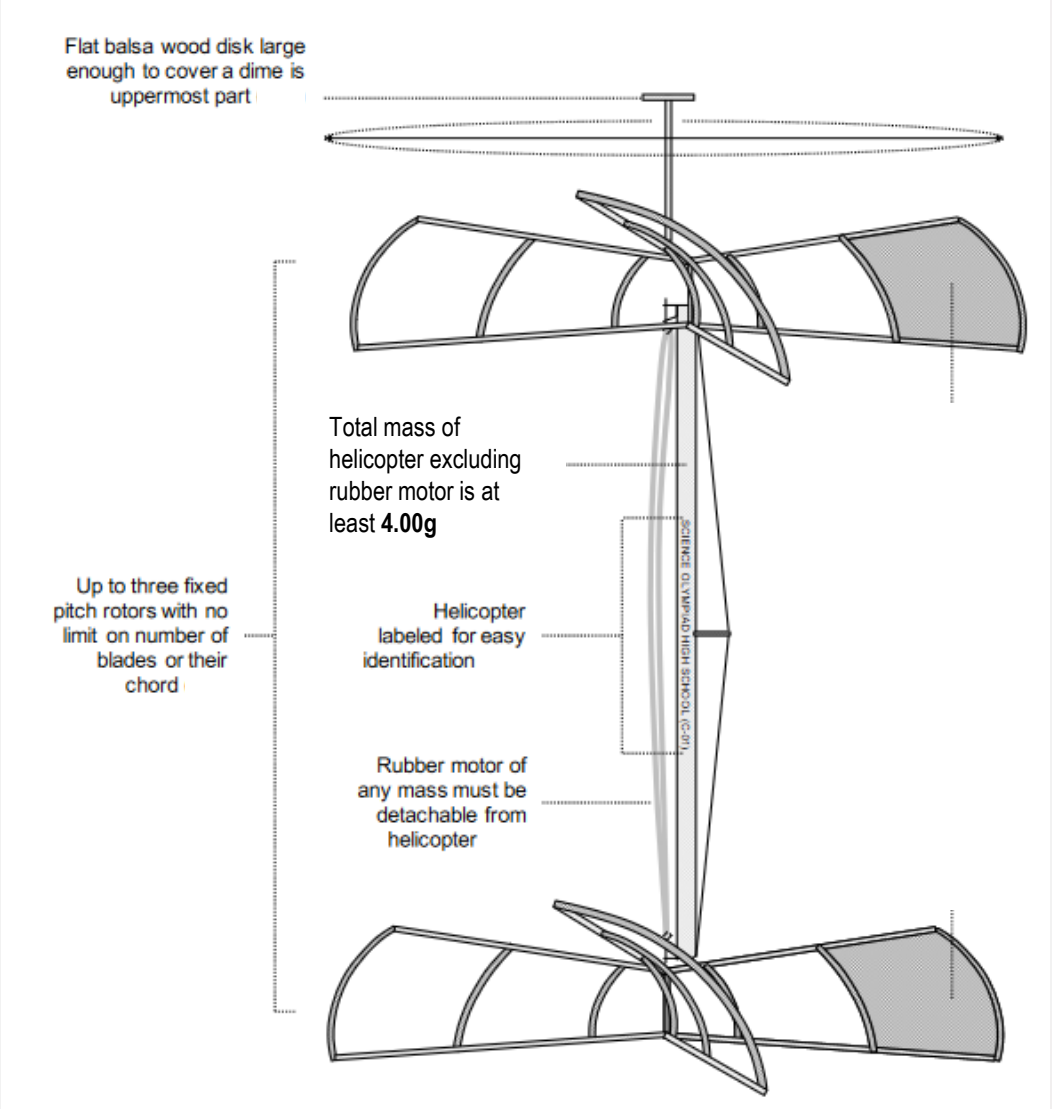
Flight Event Direction

- NOT a design event, but a flight optimization event
- Data collection and recording is critical to success
- BUILD LIGHT, try to reach the minimum allowed weight
- Build accurately. Crooked, twisted rotors do not fly well
- Take LOTS of data == Fly A Lot
- Flights can be done in a living room or classroom



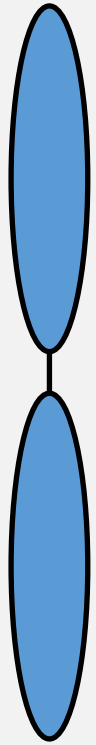
Event Parameters

- Kit, plans, or self-design
  - No pre-glued or pre-covered
- Must fit in specified box ready to fly
  - Team may buy or build a box
  - Only 1 box required ("measurement box")
  - 32cm x 24cm x 47cm
  - Box cannot change shape of Helicopter!
  - Team responsible to verify box dimensions
- Do not push the dimensions. Too big and you will be tiered
- Rotor(s) must be student-built
  - Up to 3 rotors
  - No limit on chord, diameter, or number of blades
- Up to 2 Helicopters presented for inspection
- 2-Student team
- Non-compliant Aircraft/boxes tiered
- Bonus for complete or partial log

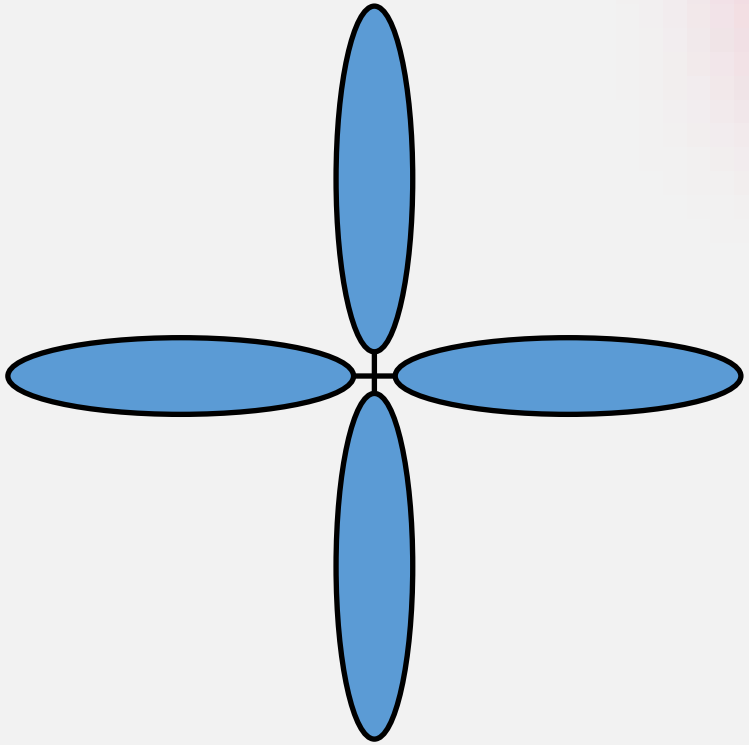


Flight Event Changes

- 10% Bonus for *only* 2-bladed rotors
- Log requires units
  - If torque meter is arbitrary, state so
- Clarification: Flat face of disk contacts ceiling



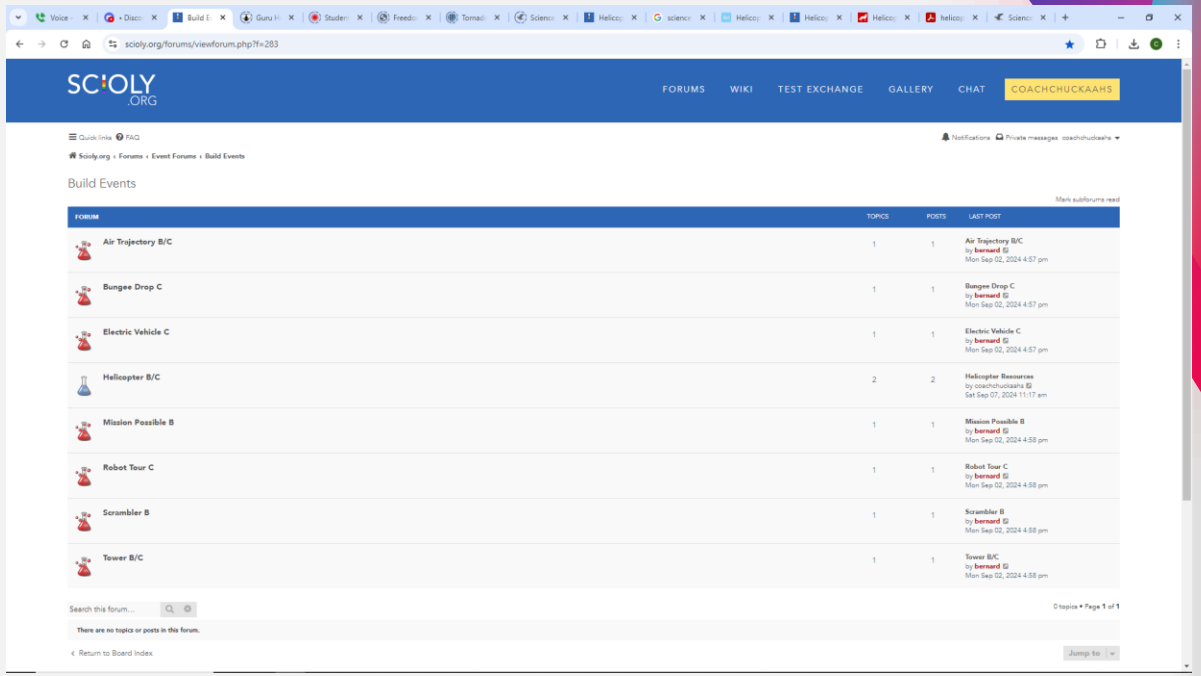
Two-bladed Rotor

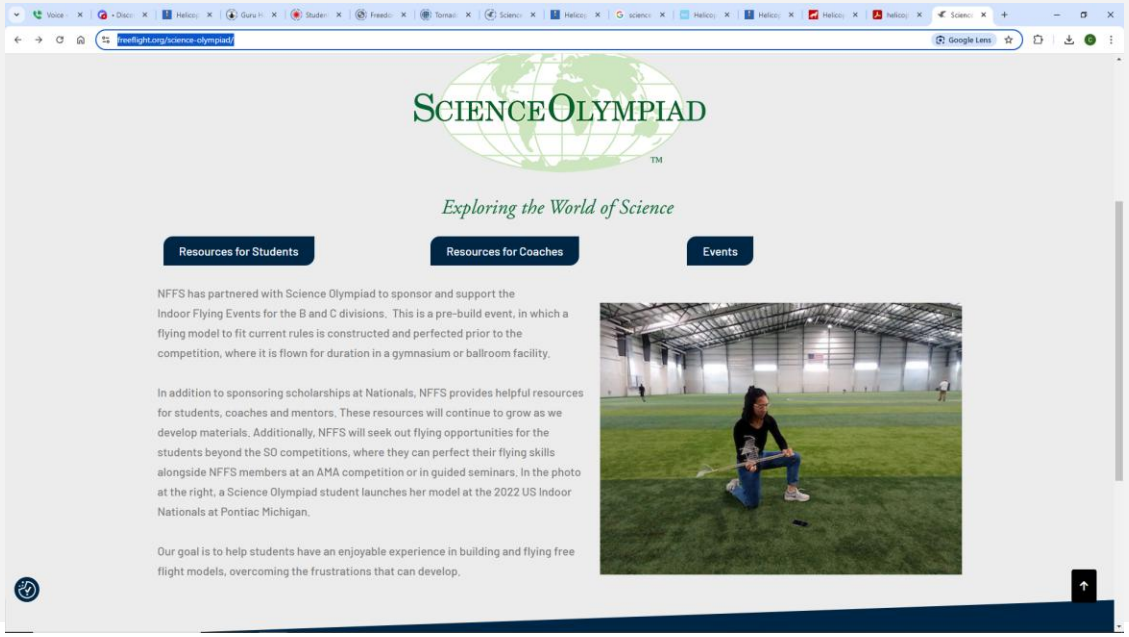


Four-bladed Rotor

Resources and help

- Extensive help resources at National Free Flight Society
  - Plans
  - Videos
  - Help and How-To Documents
- Additional Online Resources
  - SCIOLY online forums:
  - Getting Started in Heli:
  - NFFS YouTube Channel:

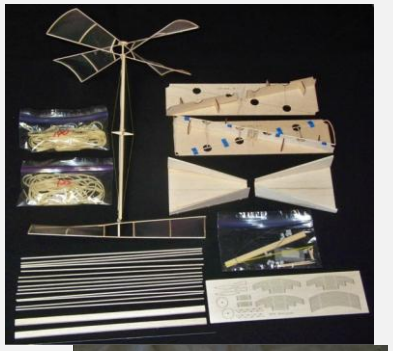




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Kits and Supplies

- Freedom Flight Models
  - https://www.freedomflightmodels.com
- J&H Aerospace
  - https://jhaerospace.com/
- Guru Engineering
  - http://main.guruengineeringtech.com/
- Laser Cut Planes
  - https://lasercutplanes.com/
- Retro RC
  - http://retrorc.us.com/scholastickitsandaccessories.aspx
- Ward Science
- Additional Supplies: See "additional Resources tab on the NFFS SO Resources website









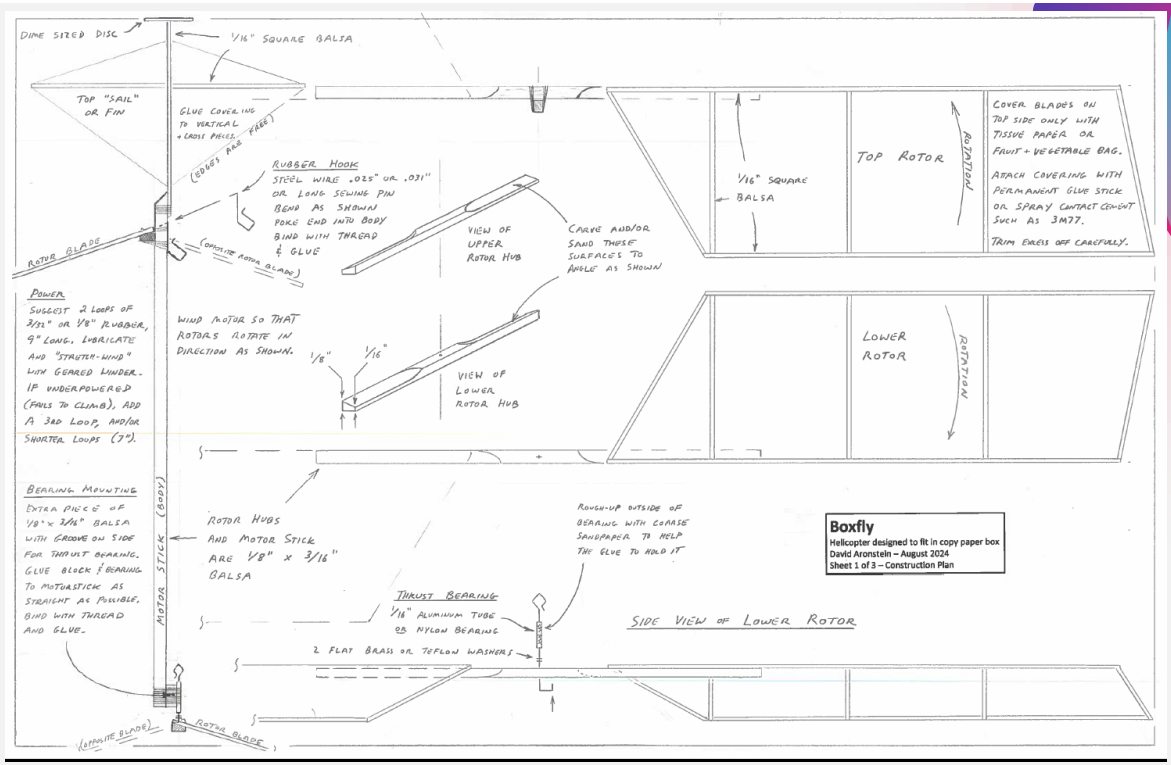


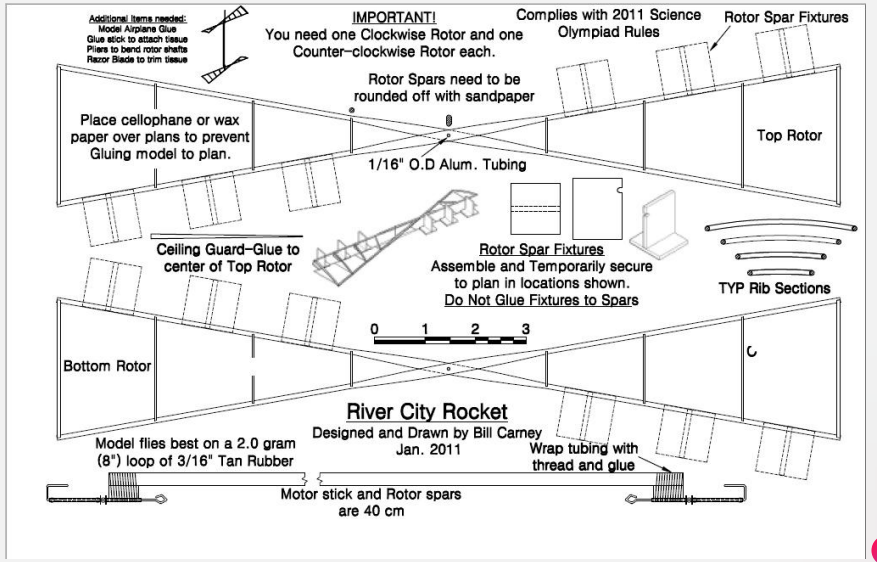
NFFS Youth Development Program

Plans

- NFFS heli plan published
  - Design by AMA flyer Dave Aronstein
  - Simple Construction and sourcing

- X-Rotor example: River City Rocket





Coaching and Mentorship

- Enlist a parent's help
  - Focus just on flight/heli
  - Easier for adult to reach out for help sometimes
- Contact NFFS
  - Locate potential local mentors (long shot)
  - YouthDev@Freeflight.org
- Contact model local airplane clubs
  - https://www.modelaircraft.org/club-finder
  - Any model airplane experience is better than none
  - I started as an R/C Pylon Racer
- Online coaching assistance: Use SO Forums
  - https://scioly.org/forums/viewforum.php?f=469



NFFS Youth Development Program

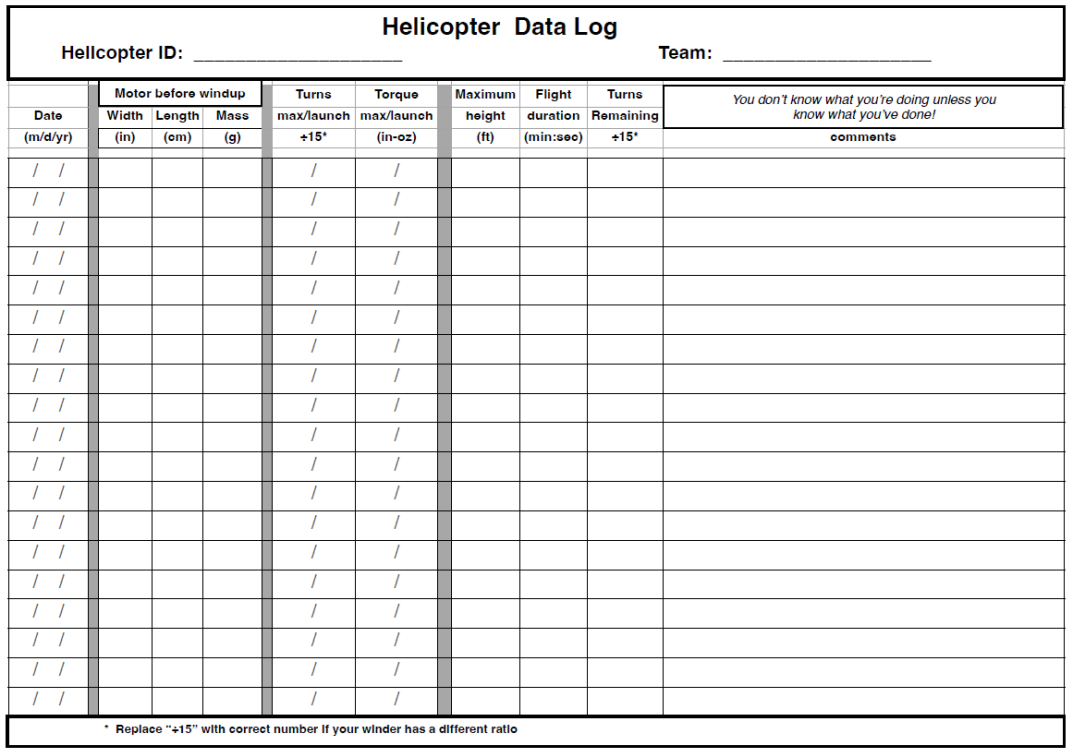
Deficiencies: Team-supplied Measurement Box

- Incorrect boxes are the most common cause of tiered entries
  - **Box outside dimensions too large**
  - **Device does not fit FULLY inside the box**
- The box is KEY to measurement of the device
  - Outside dimensions including all attachments
  - 32x24x47cm
- Top kits will need a maximized box
- Off-the-shelf boxes will NOT be maximized
- Many off-the-shelf boxes are oversized
- Build a box
  - Foam Core material from Hobby Lobby
  - NFFS Video on simple $8 box:
  - https://youtu.be/zqZR43s1SEs



Deficiencies:
Logs are incomplete or absent

- Logs are CRITICAL to flight improvement
- FREE 20% bonus!
- 10 Flights minimum, 6 parameters (3 required, 3 choice) minimum
- Example log on NFFS website
  - Complete detailed instructions
  - https://www.freeflight.org/wp-content/uploads/2025/09/Helicopter-Data-Log-w-Explanation.pdf
- Units now required
  - Torque may be "Arbitrary"



Helicopter Data Log

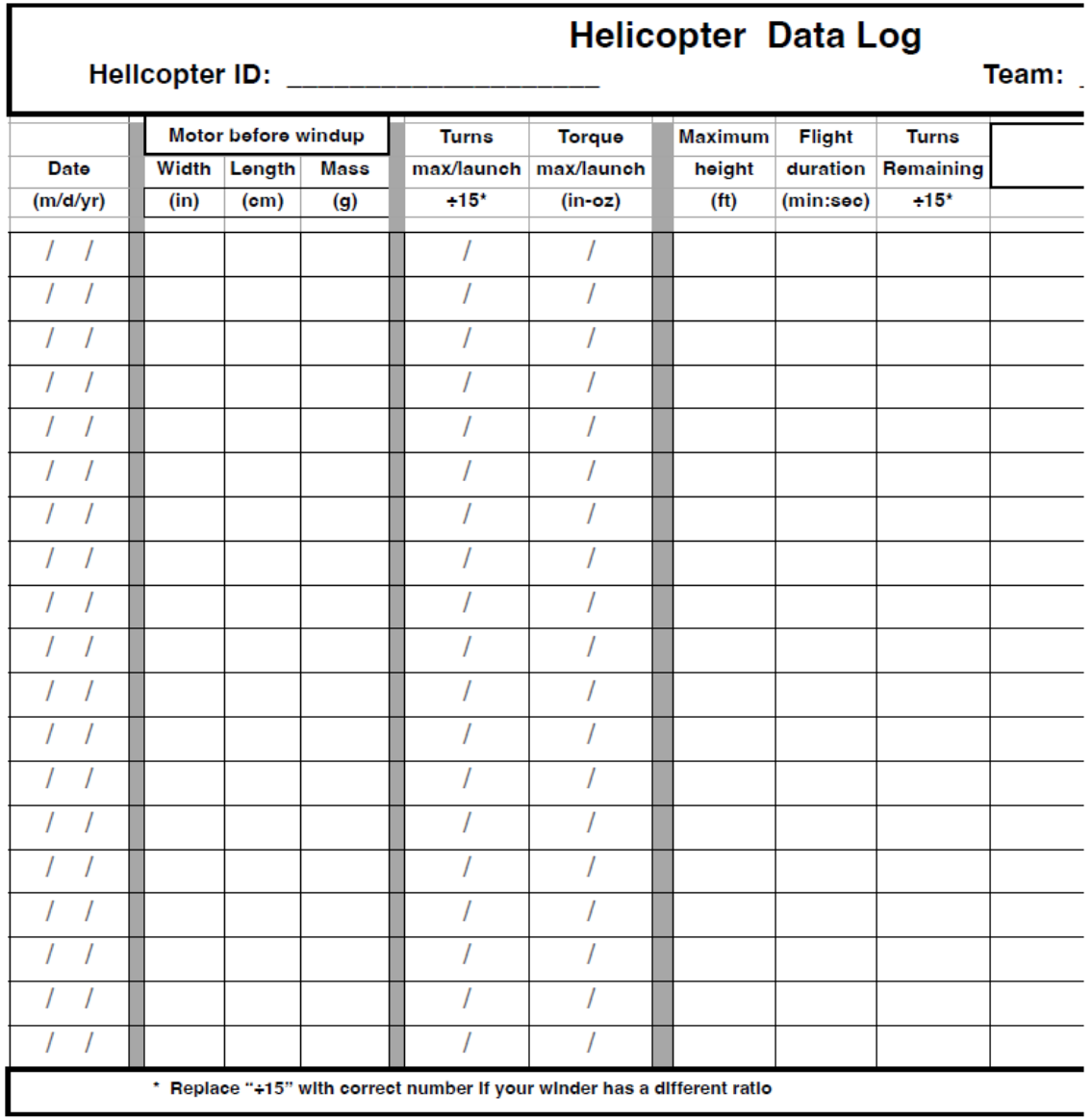
Helicopter ID: _____ **Team:** _____

Date (m/d/yr)	Motor before windup Width (in)	Length (cm)	Mass (g)	Turns max/launch +15*	Torque max/launch (in-oz)	Maximum height (ft)	Flight duration (min:sec)	Turns Remaining +15*	*You don't know what you're doing unless you know what you've done!* comments
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* Replace "+15" with correct number if your winder has a different ratio

Deficiencies: Log details

- Required entries
  - Motor size (length, width, mass)
  - Number turns or torque AT LAUNCH
  - Flight Time
- Three additional minimum columns
  - Altitude (ceiling height)
  - Torque
  - Remaining turns or torque after flight
  - Unwinds before launch
  - Rotor details (pitch, etc.)
  - Additional motor size parameters
  - Any other, MUST BE DATA PARAMETERS
    - Things you can Measure or Adjust



Helicopter Data Log

Hellcopter ID: _____ **Team:** _____

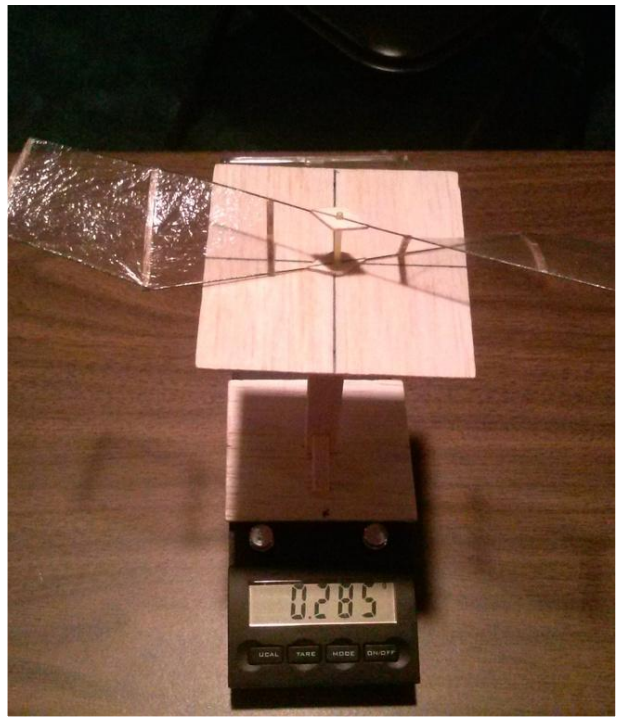
Date (m/d/yr)	Motor before windup: Width (in)	Length (cm)	Mass (g)	Turns max/launch ÷15*	Torque max/launch (in-oz)	Maximum height (ft)	Flight duration (min:sec)	Turns Remaining ÷15*	
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* Replace "÷15" with correct number if your winder has a different ratio

Deficiencies: Heavy Helicopter

- Weight is EVERYTHING in Heli
  - Excess weight needs to be lifted by spinning rotors faster
- Most kits can be built CLOSE to minimum weight (4g)
- Glue management is usually the reason for overweight
  - Over-application
  - Incorrect adhesives
  - Apply with toothpick or capillary
  - NFFS Video: https://youtu.be/owWmW_D6WYQ
- Glue Selection
  - Balsa and/or Carbon
    - Thin or medium cyanoacrylate (Hobby store, Amazon)
    - Duco thinned with Acetone (Amazon, Ace Hardware)
  - Covering
    - 3M77 Spray Adhesive
  - NEVER:
    - Hot Melt Glue (heavy)





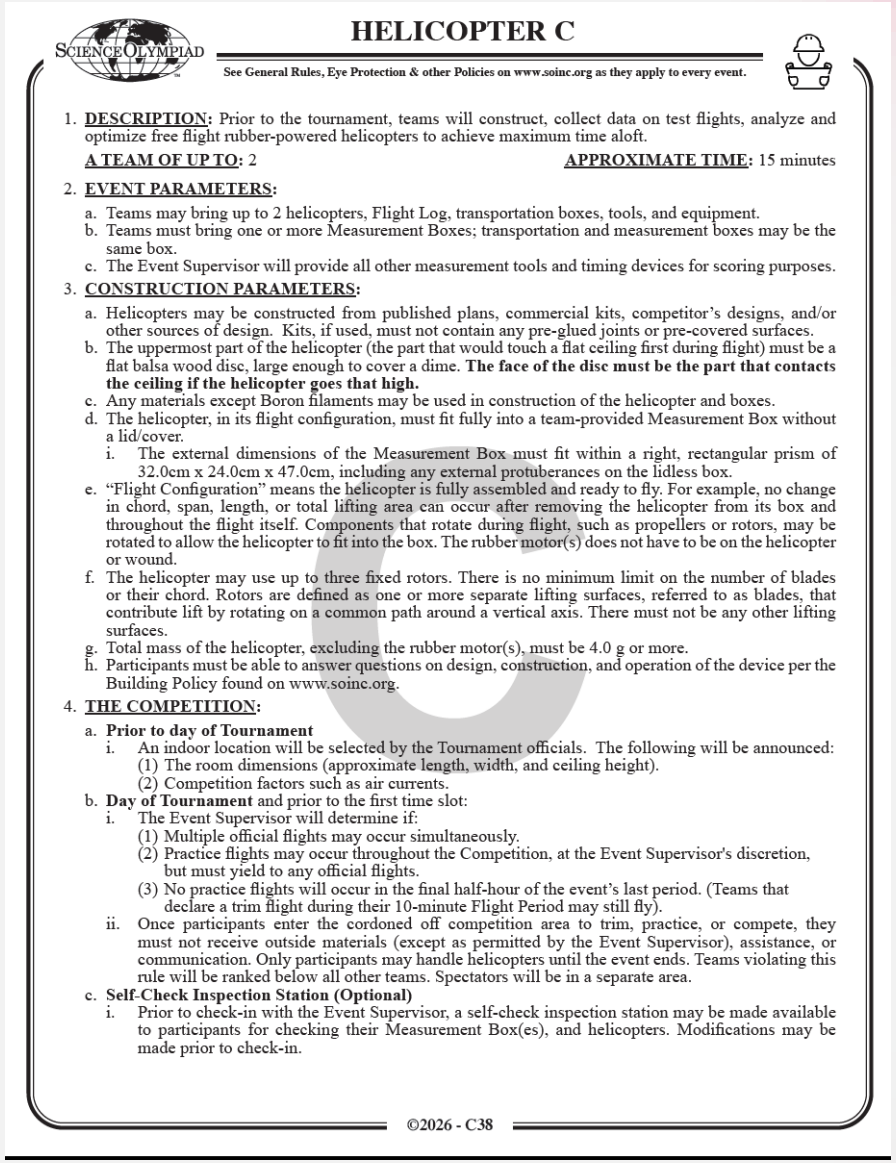
Deficiencies: Crooked Helicopter

- A Crooked Heli will not fly straight
  - Run into wall
  - Fail to support itself
- Most kits have fixture
  - Build on a FLAT SURFACE
  - Double check alignment before gluing
- Carbon Handling
  - Carbon spars may have a "warp"
  - Position warp to be parallel to build board so that the heli structure helps hold it straight
  - Vertically-aligned warp will result in incorrect pitch, leading to wobble
- Self-fixtured heli
  - Laser cut kits may not have a fixture
  - Still require a FLAT build space



Deficiencies:
Not knowing the rules

- Build
  - Materials allowed
  - Mass goal
  - Team member MUST build
  - “Rubber Powered”
- Check-in
  - Measurement box size and use
  - Must be able to answer questions on build/fly
  - Once you check in, you cannot leave or receive outside help
- Flight
  - 10-minute window to start any official flight



SCIENCE OLYMPIAD

HELICOPTER C

See General Rules, Eye Protection & other Policies on www.soinc.org as they apply to every event.

1. **DESCRIPTION:** Prior to the tournament, teams will construct, collect data on test flights, analyze and optimize free flight rubber-powered helicopters to achieve maximum time aloft.
   A TEAM OF UP TO: 2 **APPROXIMATE TIME:** 15 minutes
2. **EVENT PARAMETERS:**
   a. Teams may bring up to 2 helicopters, Flight Log, transportation boxes, tools, and equipment.
   b. Teams must bring one or more Measurement Boxes; transportation and measurement boxes may be the same box.
   c. The Event Supervisor will provide all other measurement tools and timing devices for scoring purposes.
3. **CONSTRUCTION PARAMETERS:**
   a. Helicopters may be constructed from published plans, commercial kits, competitor’s designs, and/or other sources of design. Kits, if used, must not contain any pre-glued joints or pre-covered surfaces.
   b. The uppermost part of the helicopter (the part that would touch a flat ceiling first during flight) must be a flat balsa wood disc, large enough to cover a dime. **The face of the disc must be the part that contacts the ceiling if the helicopter goes that high.**
   c. Any materials except Boron filaments may be used in construction of the helicopter and boxes.
   d. The helicopter, in its flight configuration, must fit fully into a team-provided Measurement Box without a lid/cover.
      i. The external dimensions of the Measurement Box must fit within a right, rectangular prism of 32.0cm x 24.0cm x 47.0cm, including any external protuberances on the lidless box.
   e. “Flight Configuration” means the helicopter is fully assembled and ready to fly. For example, no change in chord, span, length, or total lifting area can occur after removing the helicopter from its box and throughout the flight itself. Components that rotate during flight, such as propellers or rotors, may be rotated to allow the helicopter to fit into the box. The rubber motor(s) does not have to be on the helicopter or wound.
   f. The helicopter may use up to three fixed rotors. There is no minimum limit on the number of blades or their chord. Rotors are defined as one or more separate lifting surfaces, referred to as blades, that contribute lift by rotating on a common path around a vertical axis. There must not be any other lifting surfaces.
   g. Total mass of the helicopter, excluding the rubber motor(s), must be 4.0 g or more.
   h. Participants must be able to answer questions on design, construction, and operation of the device per the Building Policy found on www.soinc.org.
4. **THE COMPETITION:**
   a. **Prior to day of Tournament**
      i. An indoor location will be selected by the Tournament officials. The following will be announced:
         (1) The room dimensions (approximate length, width, and ceiling height).
         (2) Competition factors such as air currents.
   b. **Day of Tournament** and prior to the first time slot:
      i. The Event Supervisor will determine if:
         (1) Multiple official flights may occur simultaneously.
         (2) Practice flights may occur throughout the Competition, at the Event Supervisor's discretion, but must yield to any official flights.
         (3) No practice flights will occur in the final half-hour of the event’s last period. (Teams that declare a trim flight during their 10-minute Flight Period may still fly).
      ii. Once participants enter the cordoned off competition area to trim, practice, or compete, they must not receive outside materials (except as permitted by the Event Supervisor), assistance, or communication. Only participants may handle helicopters until the event ends. Teams violating this rule will be ranked below all other teams. Spectators will be in a separate area.
   c. **Self-Check Inspection Station (Optional)**
      i. Prior to check-in with the Event Supervisor, a self-check inspection station may be made available to participants for checking their Measurement Box(es), and helicopters. Modifications may be made prior to check-in.

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NFFS Youth Development Program

Deficiencies: Rubber Winding

- Maximizing winds in the rubber is fundamental to long flight duration
  - Don't leave the ground with an empty tank!
- Rubber thickness varies. Cut width accuracy is good
  - 10-15% variation possible within batch
  - Try several batches, or custom cut rubber
- Matching rubber to YOUR ROTORS is critical
- Highest performance with a torque meter
  - Repeatable
  - Adjusts for thickness
  - Without TM can still get 80%
- Several winding videos on NFFS Website



NFFS Youth Development Program

Deficiencies: Max Winding

- Max Turns Calculator on NFFS site: https://www.freeflight.org/wp-content/uploads/2024/09/MaxTurnsCalculator2024-25.xlsx
- Stretch winding important
  - Stretch to 5-8x relaxed length
  - Wind 50-60% max turns at full stretch
  - Walk in while applying the rest of the turns
  - Typical 2g, 0.125" loop will take about 1300 turns to break
  - 80% safely wind 1050 turns
  - Many teams put in 200-300 turns. Barely started!
- Find breaking turns
  - Break some short samples of rubber
  - Scale the turns to the mass or loop length

Deficiencies: Rubber Lube

- Without lubrication, rubber will scuff and cut itself
- Use ONLY a Silicone Lubricant
  - R/C Car Shock Oil (ebay, Amazon, hobby store)
  - Armor-all original (WalMart, Autozone)
  - Dow 33 Molykote
- Petroleum lubes will destroy rubber
  - WD-40
  - Motor oil
- Place some lube in a ziplock bag. Then add rubber loop and squish it around

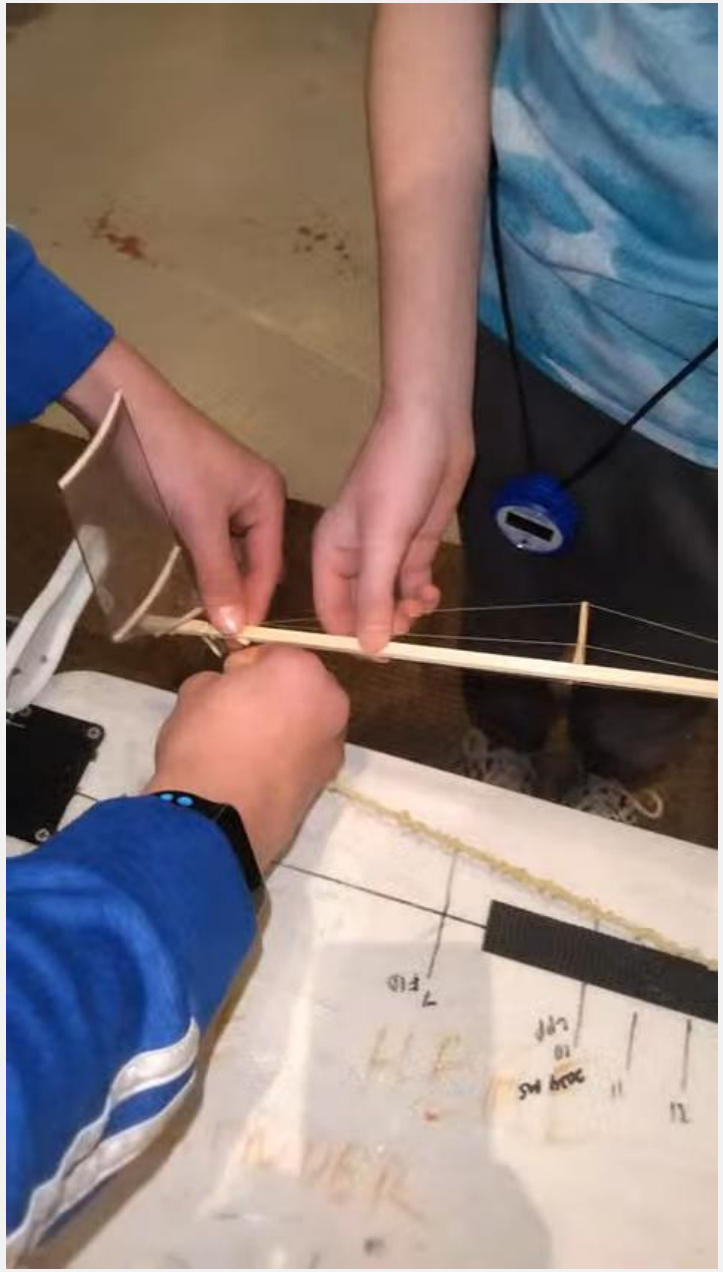






Deficiencies:
Safe Winding Off Heli

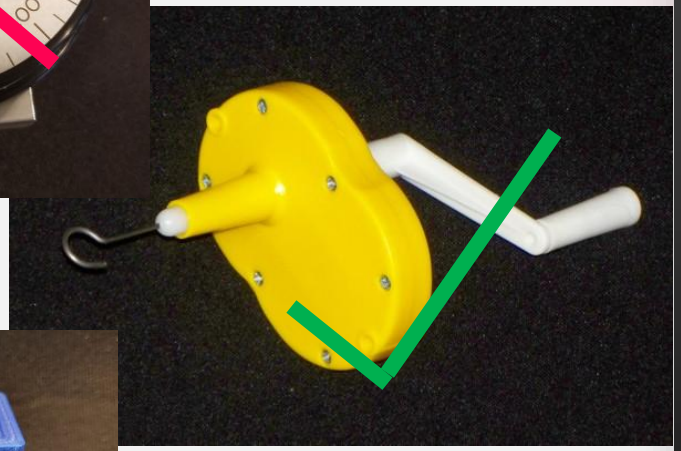
- Proper winding
  - Wind to near breaking torque
  - Risk of breaking on heli and doing damage
  - Risk of over-torquing heli parts
- Wind on a torque meter or stooge
  - Clamp to bench or chair, or have partner stand on a board with TM or stooge
  - Simple hook or screw-hook can be a stooge
- Transfer to Heli after unwind
  - Unwind a few turns to safe level for heli, based on testing
  - Keep wound length same as heli hook-to-hook. Changing length can make stringy knots
  - Keep heli motor stick in line with rubber at all times.
    - Side load can (will) break motor stick or hook
  - Use O-rings for easy transfer
    - Buna rubber are easiest



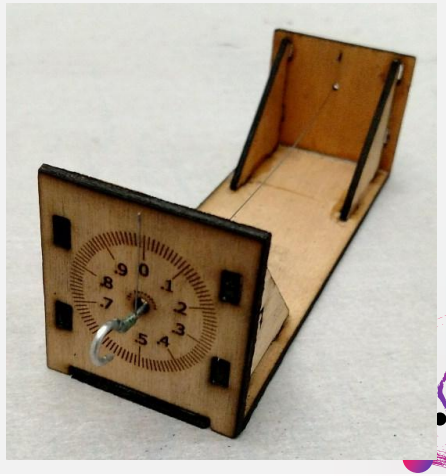
Deficiencies:
Incorrect Winder and Torque Meter

- 20:1 winder may be hard to get to full torque
  - 10:1 winder is best for this heavy rubber
- Some expensive winders not suitable for high torque
  - Gear failures observed
  - IFFS/Geauga winder may not hold up
- Torque meter
  - Some simple torque meters do not go high enough
  - 1 full turn on TM wire will generally start doing damage
  - Simple wood/wire TM may require heavier element
    - Try 0.025” music wire instead of 0.015-0.020”
    - Guitar string or wire from hobby shop
    - K&S Music wire generally good
  - Digital torque meters generally have high capacity



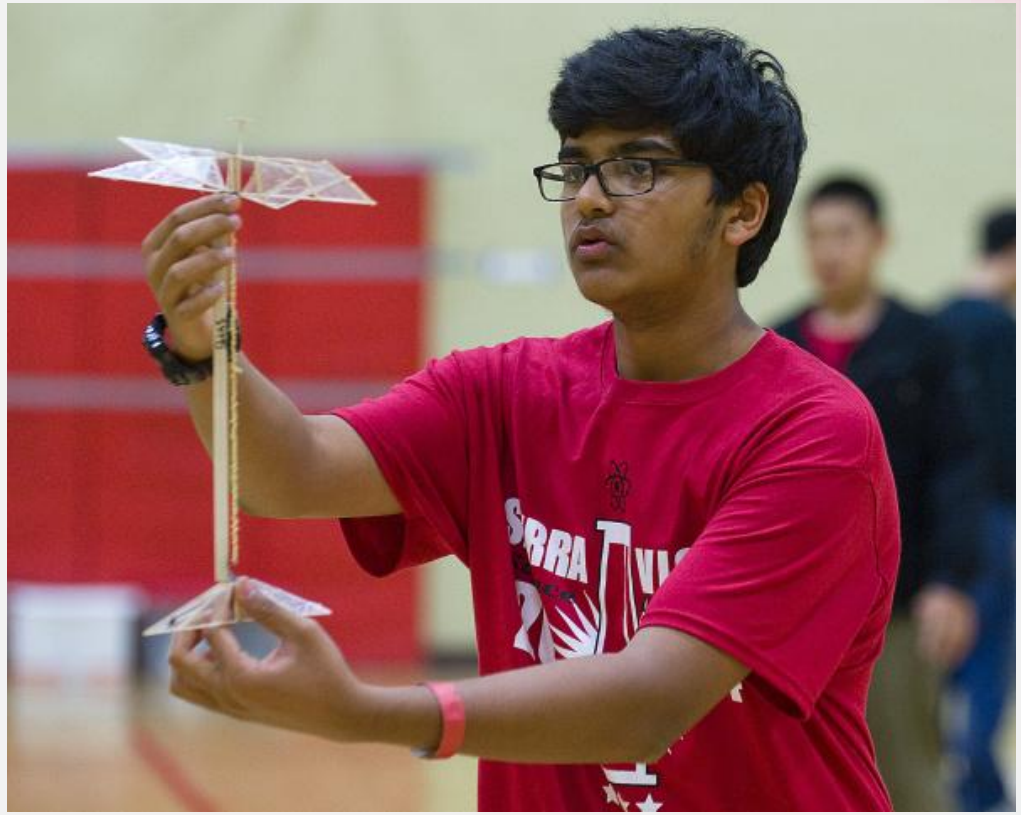






Deficiencies:
Incorrect Handling and Launching

- If at all possible, ONE PERSON IN CONTACT at a time
- Choreograph competition movements
  - Minimize motion around heli
  - Know who will do each step
  - Minimize reaching across / awkward positions
  - Practice like you compete
- Launch straight
  - Team member check verticality
  - Communicate!
  - Release, do not toss!
- If possible, let rotors spin up for 1 second before releasing Heli
  - Helps prevent "tucking" of soft rotors



Flight Optimization: Straightness

- A straight heli at 5g or less and decent winding should easily attain 30-60 seconds
- Crooked climb
  - Look at build straightness
  - Match pitch angle on each rotor blade
  - Fix (reglue) any crooked parts
  - Bottom rotor pitch equal or higher than top rotor
  - Unbalanced (mass) rotor blades
- Does not reach ceiling
  - Look at winding technique.
  - Compare to 80% of max turns calculator
  - Use wider rubber (mostly at least 1/8”)



Flight Optimization: Key Flight Variables

- CG Location (balance point)
  - Can impact stability
- Rubber Total Mass
- Rubber width
  - Better: Linear density, accounts for width and thickness
  - Carefully measure rubber blank length
  - Mass blank to 0.001g
  - Divide to get g/in, linear density
  - Catalog rubber blanks by density
- Launch Torque
  - Back off to reduce fluttering blades
  - Back off to protect Motor stick
- Adjust one variable at a time!



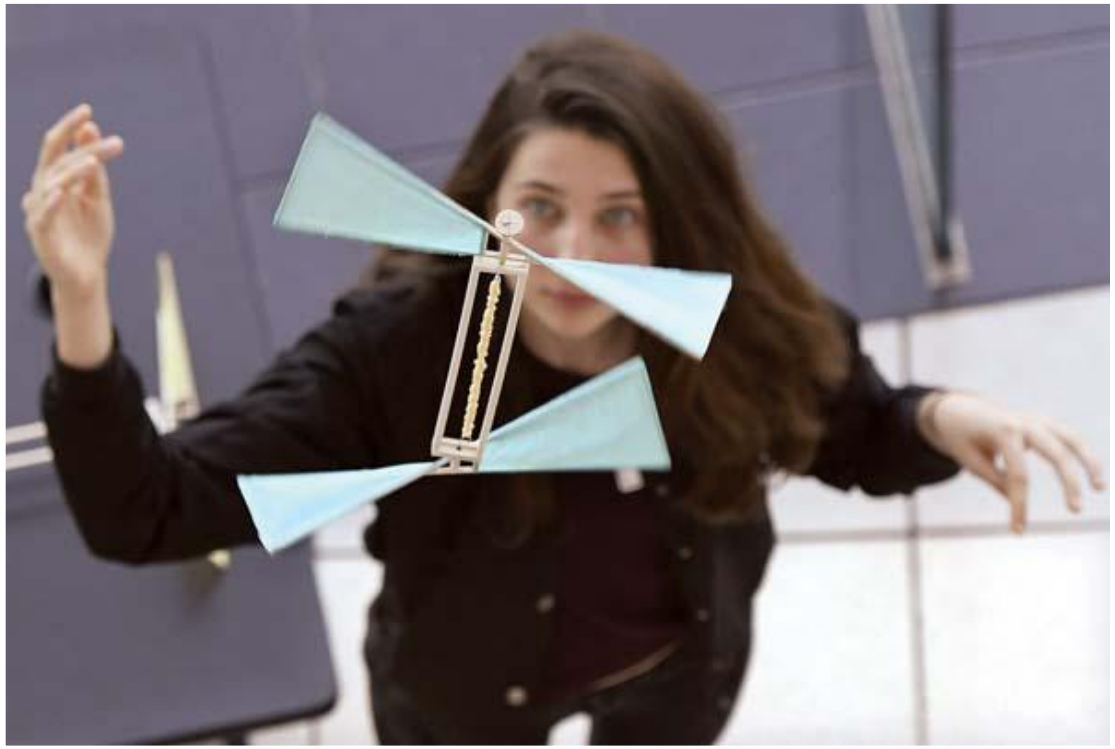
Helicopter Data Log

Hellcopter ID: _____ **Team:** _____

Date (m/d/yr)	Motor before windup Width (in)	Length (cm)	Mass (g)	Turns max/launch ±15°	Torque max/launch (in-oz)	Maximum height (ft)	Flight duration (min:sec)	Turns Remaining ±15°	*You don't know what you're doing unless you know what you've done!* comments
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Flight Optimization: Rubber / Rotor Matching

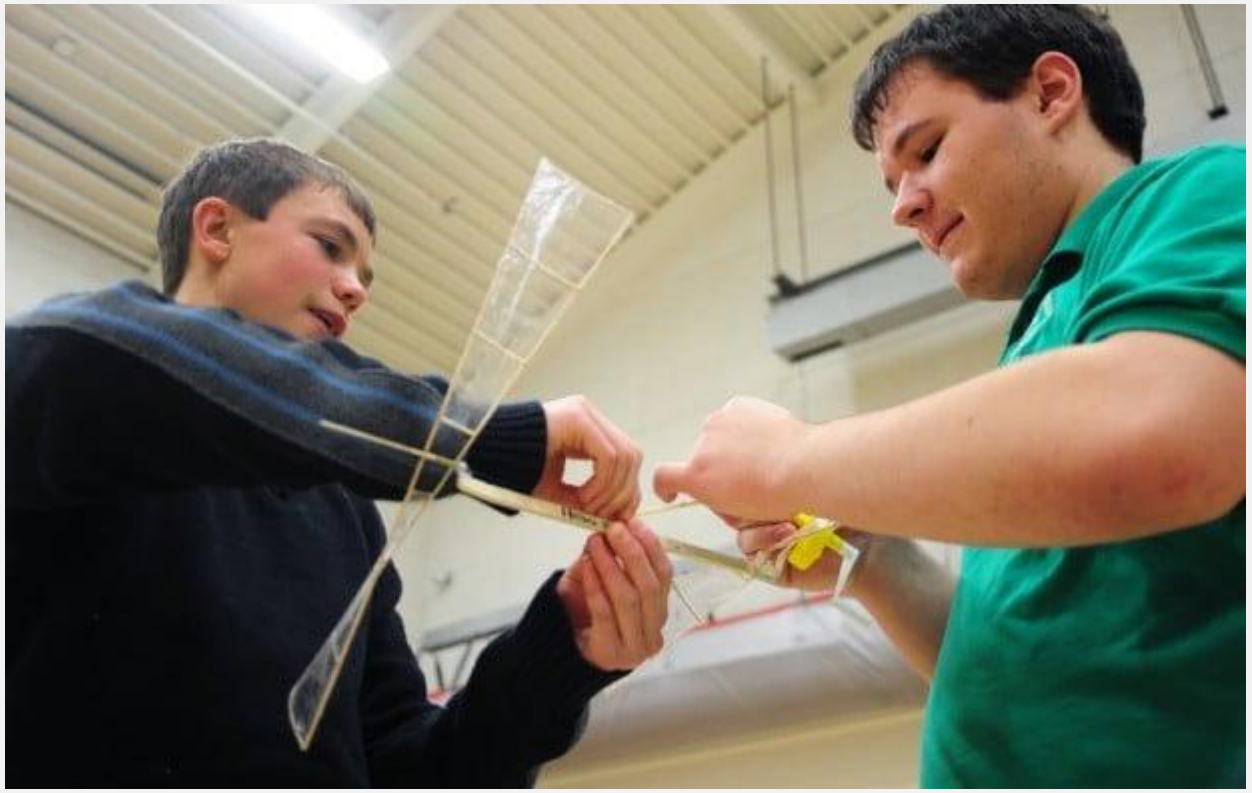
- Two-parameter optimization
  - Rubber width
  - Rubber mass or length
- Fix one parameter (width) and vary the other (length or mass) to find optimum (stopwatch)
- Adjust fixed parameter and repeat
  - Note: if you only have one rubber width available then optimize the mass or length only
  - Stock rubber width may vary in linear density due to thickness variations. Do not assume all pieces of rubber from one batch are the same
- Optimum
  - Max time on the stopwatch is best indicator
  - Too many turns remaining indicate use wider rubber or shorter loop (less mass)
  - Run out at ceiling indicates use thinner rubber or longer loop (more mass)



Flying

- Record ALL parameters in log
  - Change ONE THING at a time
- Rubber optimization is key
  - Stopwatch tells the tale
- TEST TEST TEST
  - Winning takes many flights
  - No longer need a gym. Can test in a classroom
  - Be sure to test in a taller ceiling before competing, to ensure stability in the climb





Follow-up

Preferred followup is the Scioly Forum at https://scioly.org/forums

NFFS YDP: YouthDev@Freeflight.org

Official rules clarifications are thorough the SO FAQ process ONLY

https://www.freeflight.org/science-olympiad/science-olympiad-resources/