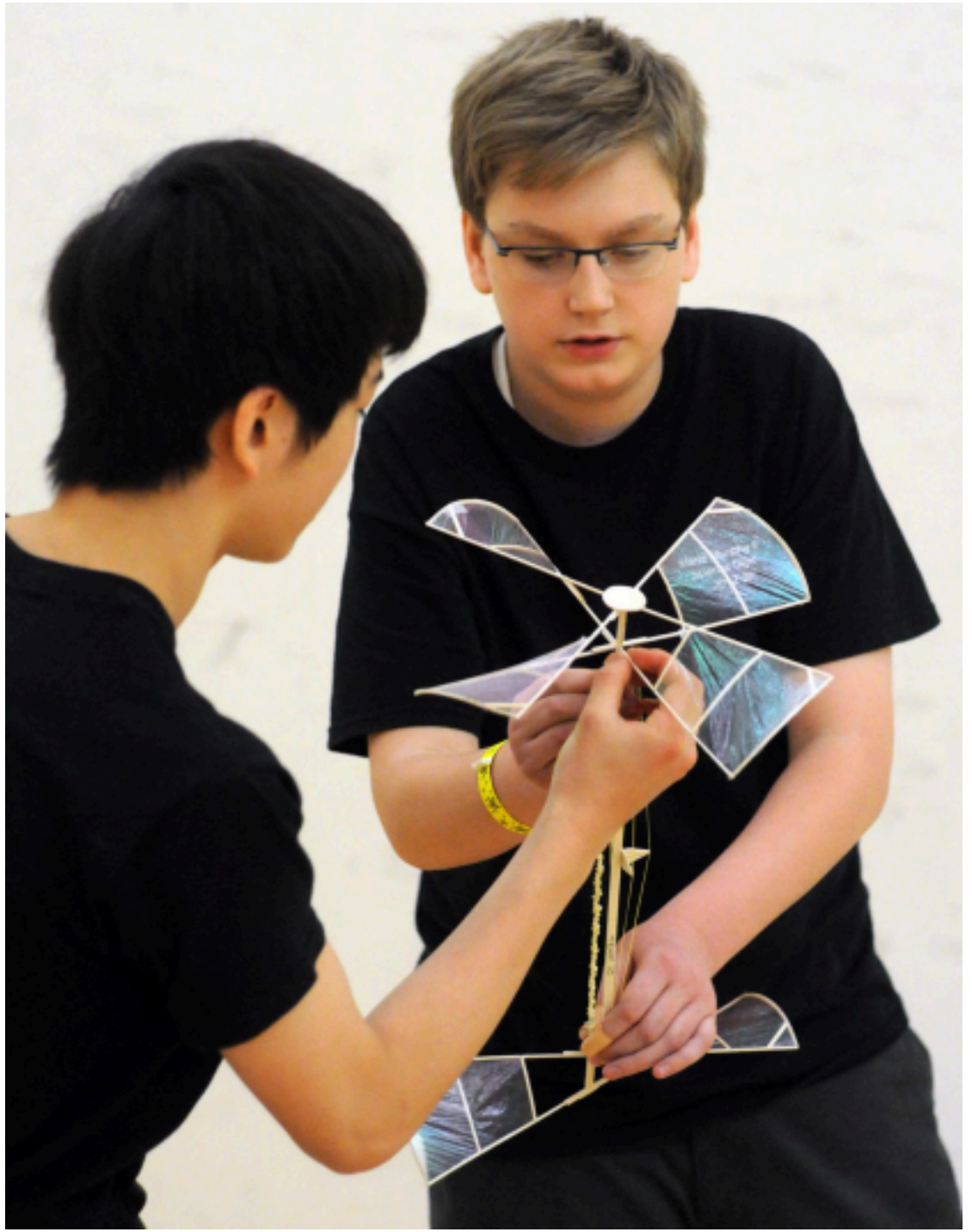
NFFS

YOUTH DEVELOPMENT PROGRAM

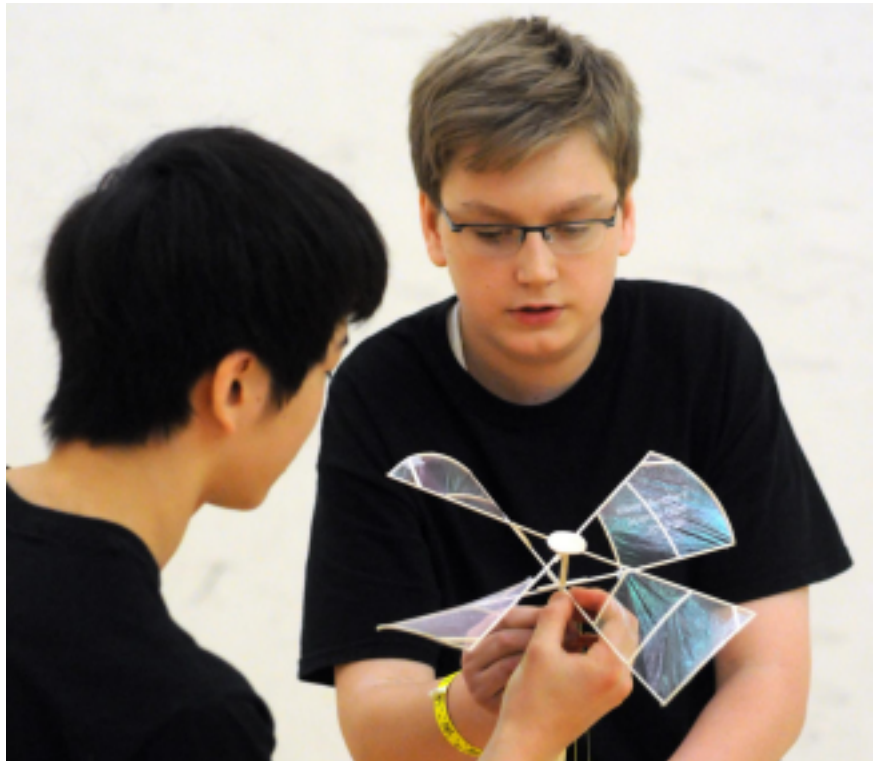


Presentation Order

- Event descriptions and rules
- Sources of materials and aid
- Building techniques
- Flying

Helicopter Event Description

- Prebuild event
- Rubber Powered Indoor Helicopter flown for Duration
- Made with any materials except



Boron

- Presented in a box with outer dimensions specified
- Best of two flights duration
- Kits are permitted
- Student-Built

Flight Event Changes

- Changed from any aircraft to Helicopter only
- Changes to box dimensions
- Unlimited motor mass •



Aircraft mass 4.0g

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")
- B&C: 32cm x 24cm x 47cm (**8-ream** paper box)
- 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 must be student-built
- Up to 3 rotors
- No limit on chord, diameter, or number of blades
- Labelled for identification
- Up to 2 Helicopters presented for inspection •

2-Student team

- Non-compliant Aircraft/boxes tiered

helicopter excluding rubber motor is at least **4.00g**

Total mass of

Additional Event

Parameters

- 4g minimum without rubber
    - Weight is critical
- Rubber powered
    - Rubber MUST be removeable for massing device
- Dime-sized balsa disk must be upper-most part if helicopter, contacts ceiling
    - Prevents sticking to ceiling



Flexibility of Design

- Simplest design is two rotors, coaxial
    - One rubber motor to wind
    - Easiest to make weight
- Chinook style allowed
    - Multiple rubber motors complicate winding
    - Box limitations may negate advantages of multi-axis arrangement
- Unspecified rotor configuration
    - Chord
    - Number of blades
    - Diameter (must fit box assembled)



Flight Event Flight Log

- Complete log is 20% bonus, Incomplete 10% bonus •

10 flights minimum

- Required entries
  - Motor size (length, width, mass)
  - Number turns or torque AT LAUNCH
  - Flight Time
- Three additional minimum columns
  - Altitude
  - Torque
  - Remaining turns or torque
  - Unwinds before launch
  - Rotor details
  - Additional motor size parameters
  - Any other, MUST BE DATA PARAMETERS
- Log is critical to improving
- Sample log with instructions on NFFS website



Event Flying Process

- Indoors, with room dimensions published in advance
  - Smooth ceiling highly preferred over girdered
- No coaching or communication once in competition area

- ONLY PARTICIPANTS may touch heli and box. This means DO NOT let officials attempt to measure/weigh
- Flight log: 20% bonus if complete, 10% if incomplete
- Clock: A 10-minute flight clock when motor is given back to the team
  - No time-out for retrieval or repairs
  - A flight starting in 10-minute window may go to completion
- Trim flights permitted during 10-minute competition window, but must be announced as trim
- Score best duration of 2 official flights, plus bonuses
- Construction violations are tiered



ES Experience Issues and Observations

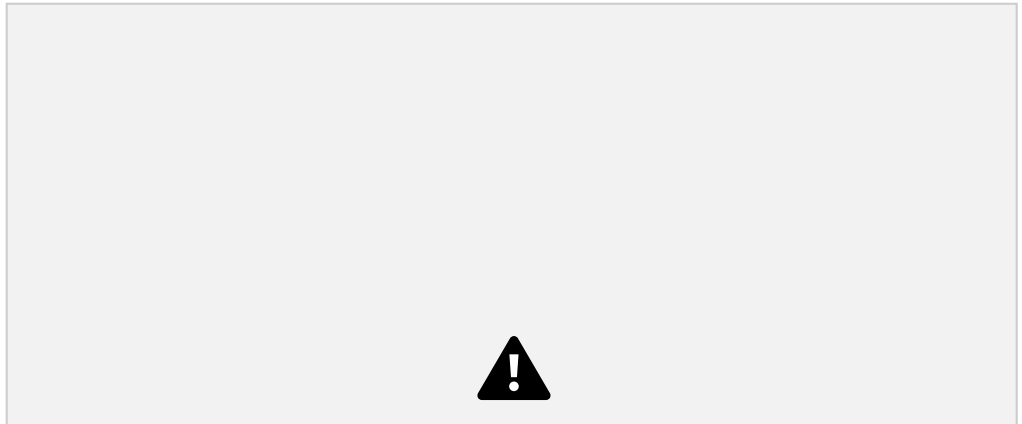
- Insufficient Logs
  - Only 10 entries (or less)
  - Too few columns
  - Meaningless columns (e.g.: date)
  - *Logs are a critical element of improvement*
- Crooked construction

- Accurate construction is critical
- Heavy models: Too much glue!
  - Not flying the same in practice and competition
    - Do not let observations of others change your approach!
- Incorrect box size
  - YOU are responsible to verify your box is legal!
    - OUTSIDE dimensions specified



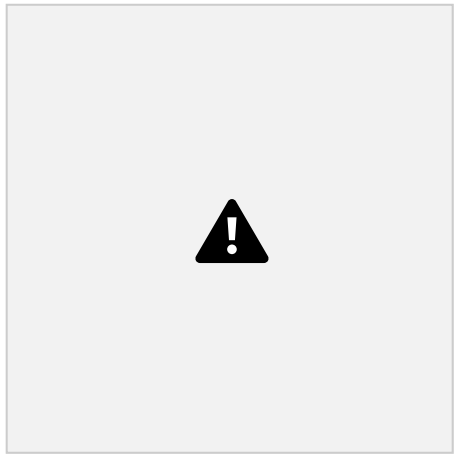
Thoughts for improvement

- Spend more time in testing than in build
- Keep detailed logs



- Read and follow rules carefully
- Use resources, especially the online forum at Scioly
- NFFS continues to develop resources and videos, see https://www.freeflight.org/science olympiad/science-olympiad-resources/





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

Sources

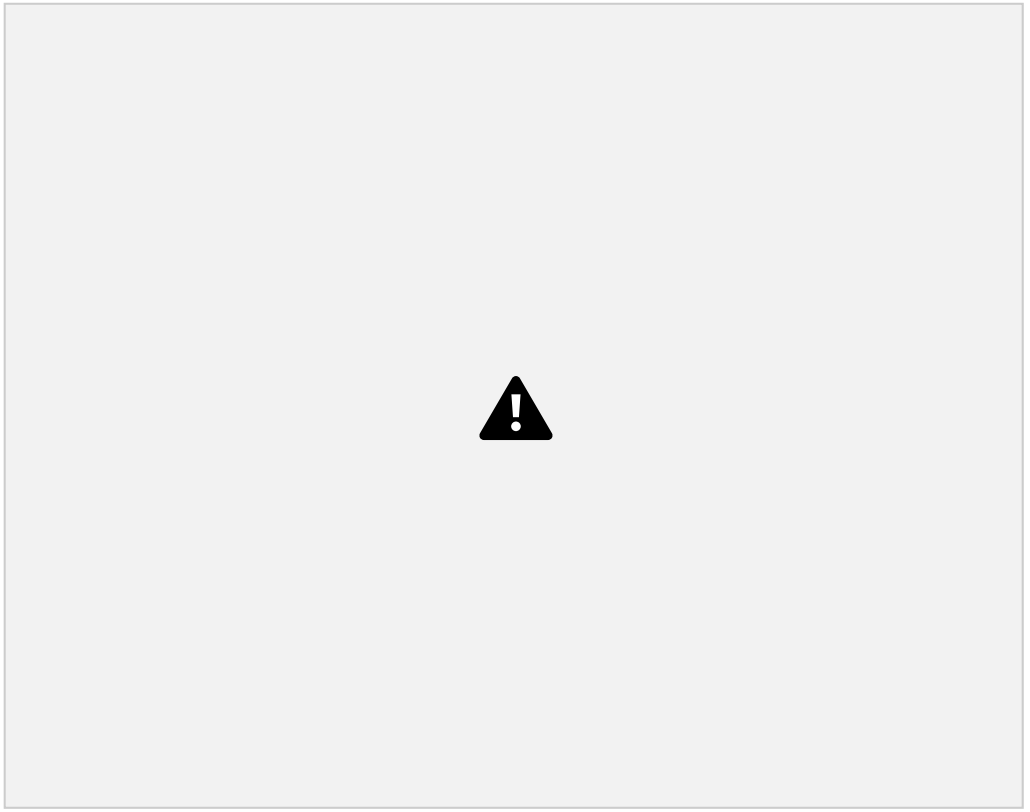
Kits

Supplies

Help

Kits

- Ward's Science
  - Official Science Olympiad Supplier
  - "Kit" includes tools, glues, etc. to get you started
  - Generally more "Open Ended" than other kits
    - Less direct design and guidance
    - Not as refined
  - Heli kit not yet announced

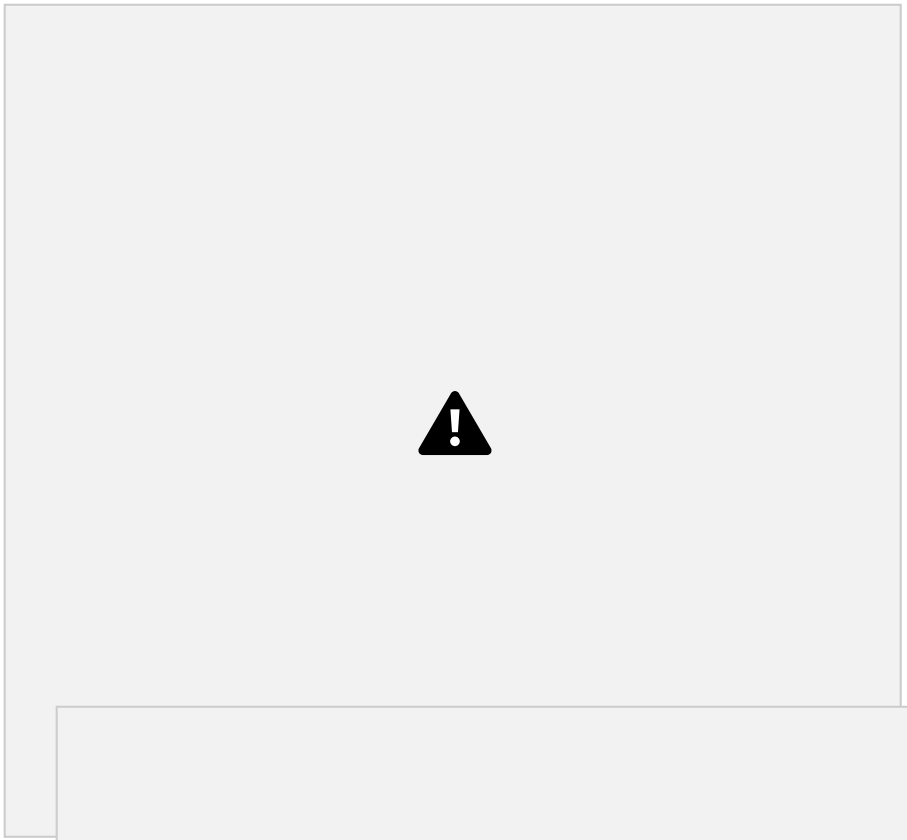


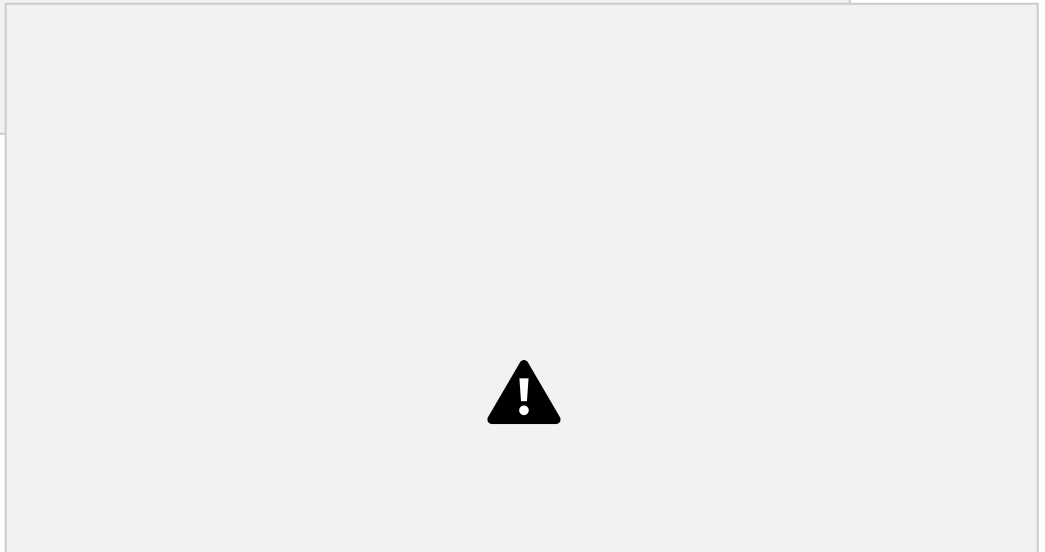


Kits

- Freedom Flight Models
  - Complex but competitive, consistently in top 10 at Nationals
  - Consistent quality
  - EXTENSIVE instructions
  - https://www.freedomflightmodels.com
  - Helicopter kits expected early October
- Also a full stock of accessories
  - Torque meter
  - Winder
  - Counter
  - Rubber
  - opellers

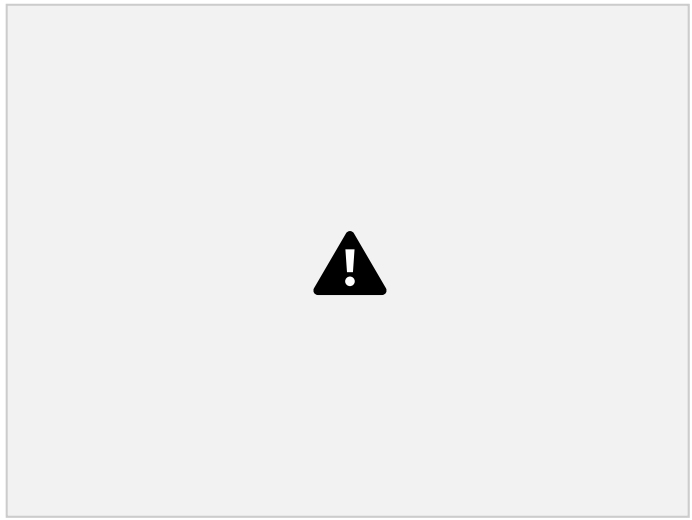






Kits

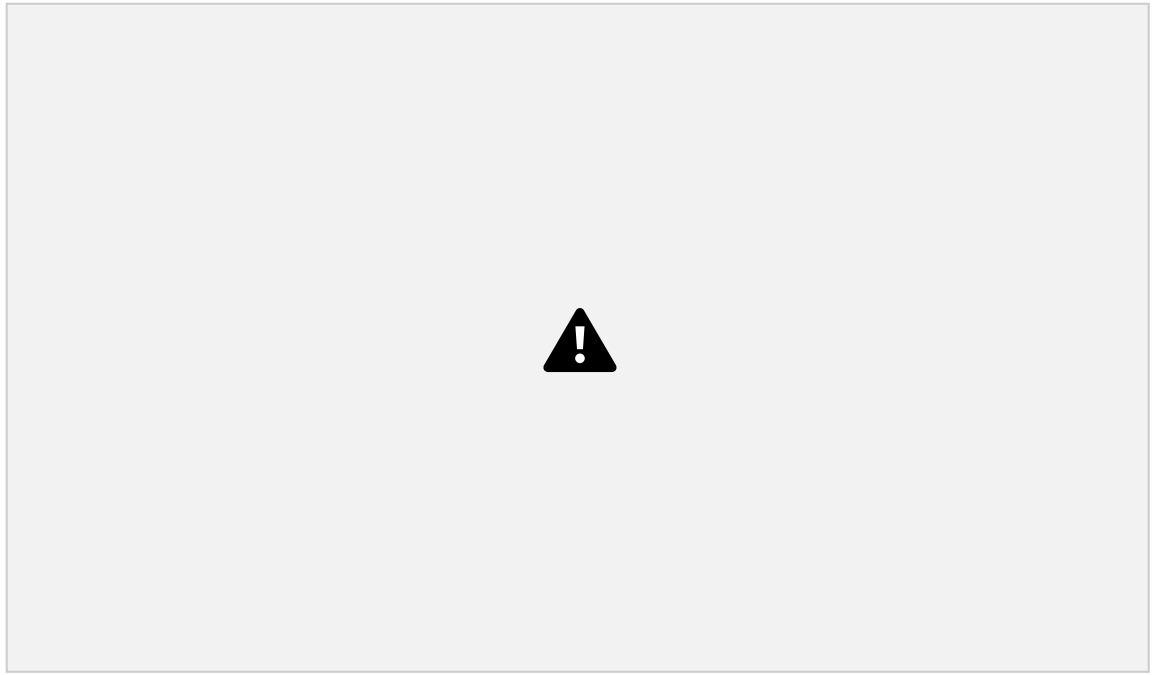
- J&H Aerospace
  - Competitive indoor flyer designs
  - Pre-rules heli sold, Team MUST compare to published rules
  - Two versions
    - Tornado: Built up rotors
    - Twister: Simple sheet rotors
  - Many good YouTube videos
  - Building and flying tools and supplies
  - https://jhaerospace.com/





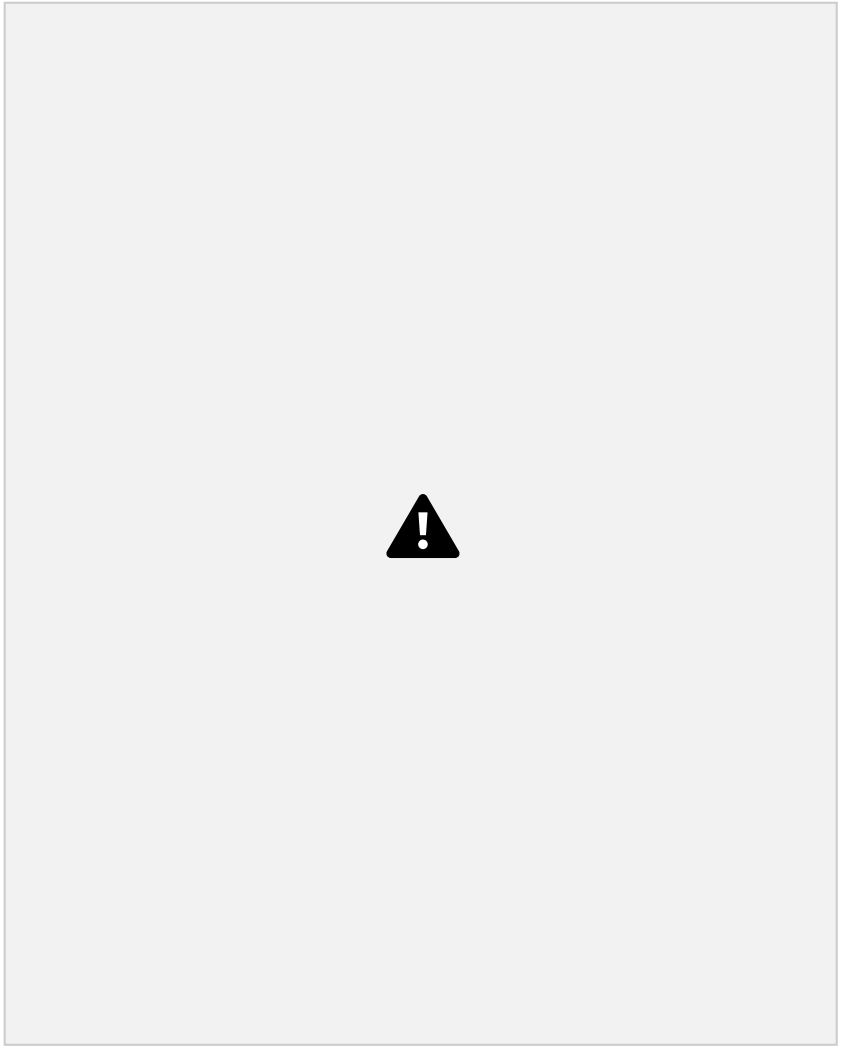
Kits

- Laser Cut Planes
  - Simple building
  - Good flying design
  - Low cost
  - Photo-instructions, no plans
  - https://lasercutplanes.com/
  - Known for simple assembly
  - Heli kit planned but not yet on web site

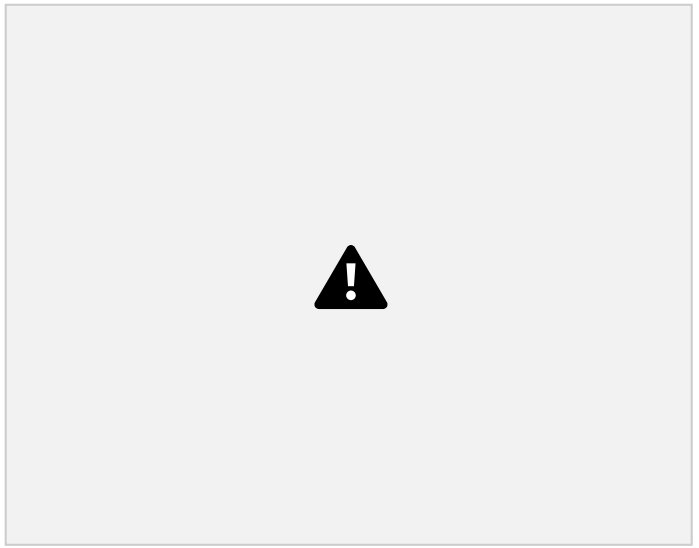


Kits

- Guru Engineering
  - Non-profit
  - Easy-to-build laser cut kits
  - Designed to fit commercially available boxes • Kit builds two helis plus two spare rotors • Detailed instructions with photos
  - http://main.guruengineeringtech.com/

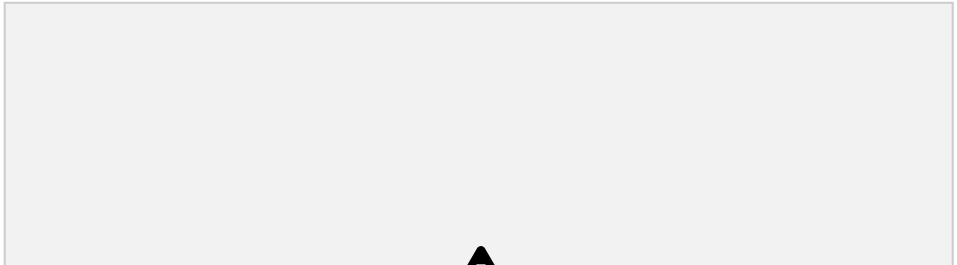






Kits

- Retro R/C
  - Complete line of kits and parts
  - Low prices, around $50 for two kit package • Has not yet announced a 2025 Helicopter kit •



http://retrorc.us.com/scholastickitsandaccessories.aspx

Plans

- NFFS heli plan published
  https://www.freeflight.org/science-olympiad/science olympiad-resources/
  - Design by AMA flyer Dave Aronstein
  - Simple Construction and sourcing
- X-Rotor example: River City Rocket
- Jim Richmond AMA Heli

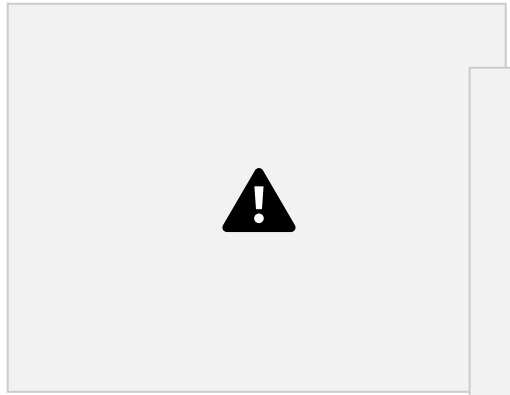
- Record holding design
- Less than ½ gram
- Possible to glean ideas

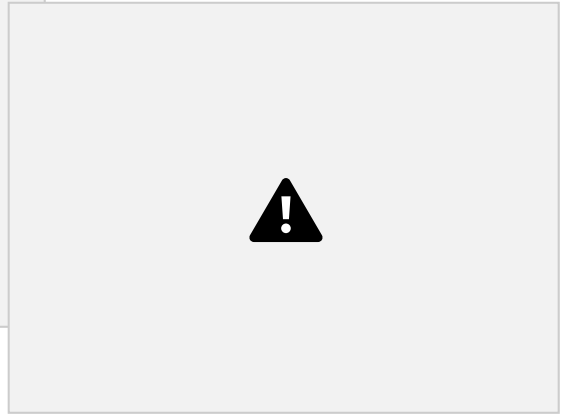


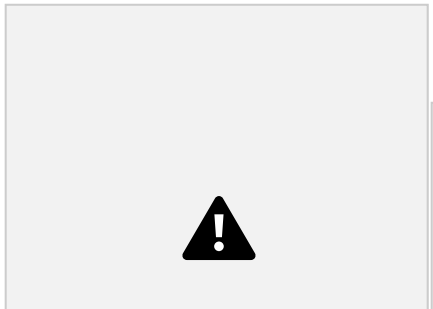
Accessories

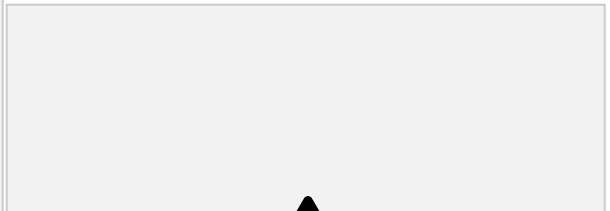
- Rubber, Winders, Torque meters, covering • Indoor Free Flight Supply
  - https://www.indoorffsupply.com/
- Freedom Flight Models
  - https://www.freedomflightmodels.com
- FAI Model Supply
  - https://www.faimodelsupply.com/
- J&H Aerospace
  - https://jhaerospace.com/
- Retro R/C
  - http://retrorc.us.com/scholastickitsandaccessories.aspx •

Volare Products







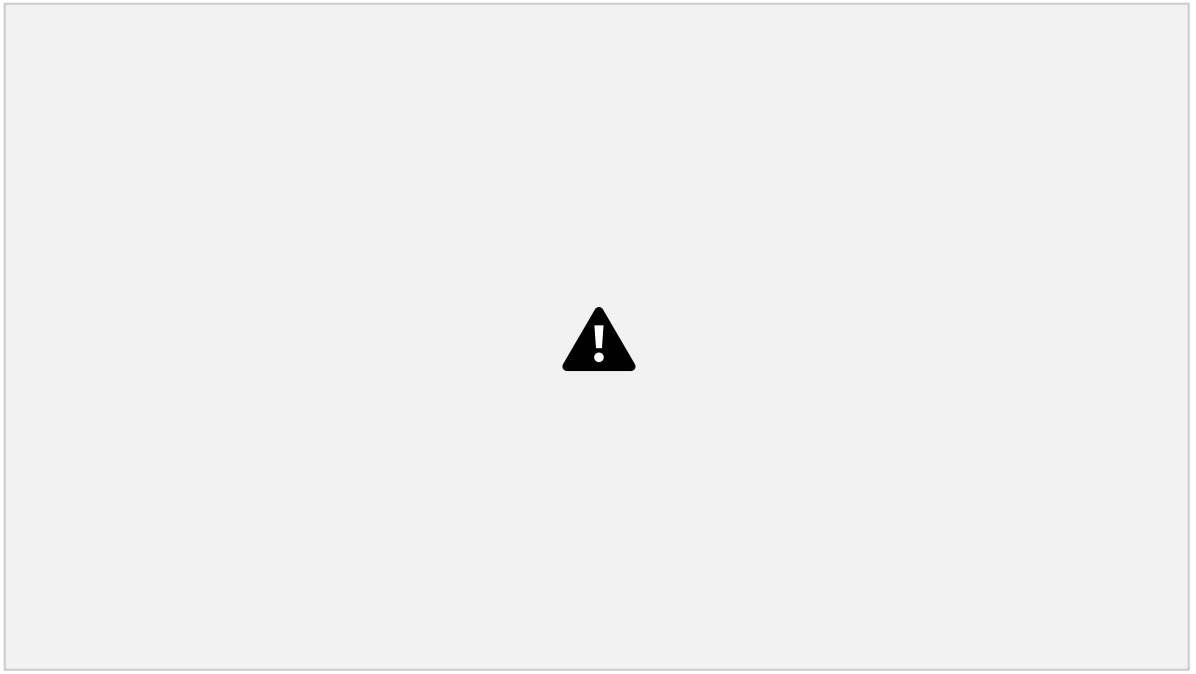


- https://volareproducts.com/wordpress/

- Covering, prop hangers, rubber stripper
  - Indoor Model Specialties
  - http://www.indoorspecialties.com/



Resources and help

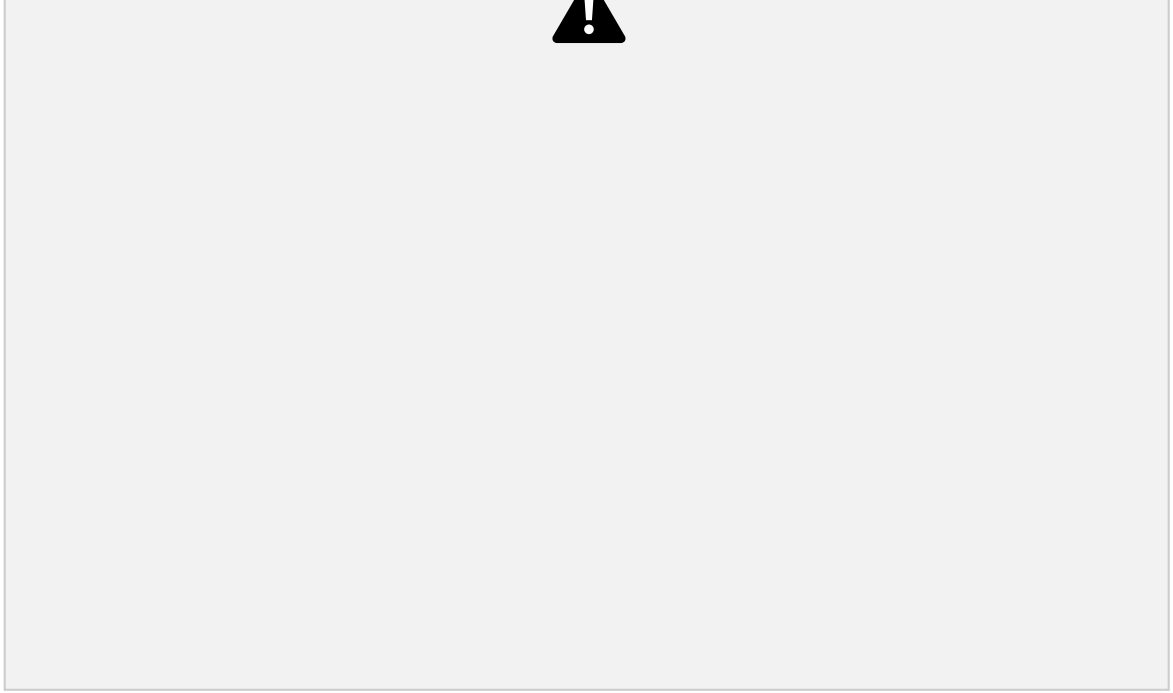


- Plans
  - Hip Pocket Aeronautics at http://www.hippocketaeronautics.com • National Free Flight Society at https://freeflight.org/join-learn-fly/science-olympiad/
- Online Resources
  - National Free Flight Society at https://freeflight.org/join-learn- fly/science-olympiad/ includes videos, plans, how-to guides, etc. • SCIOLY online forums at https://scioly.org/forums/viewforum.php?f=283
  - Hip Pocket Aeronautics forums

https://www.hippocketaeronautics.com/hpa_forum/index.php?board=33.0

- Minimizing weight gain:
  https://www.soinc.org/sites/default/files/uploaded_files/glueweight.pdf
- Basic Building:
  https://www.soinc.org/sites/default/files/uploaded_files/ScienceOlympia d5.0.pdf





Building Technique

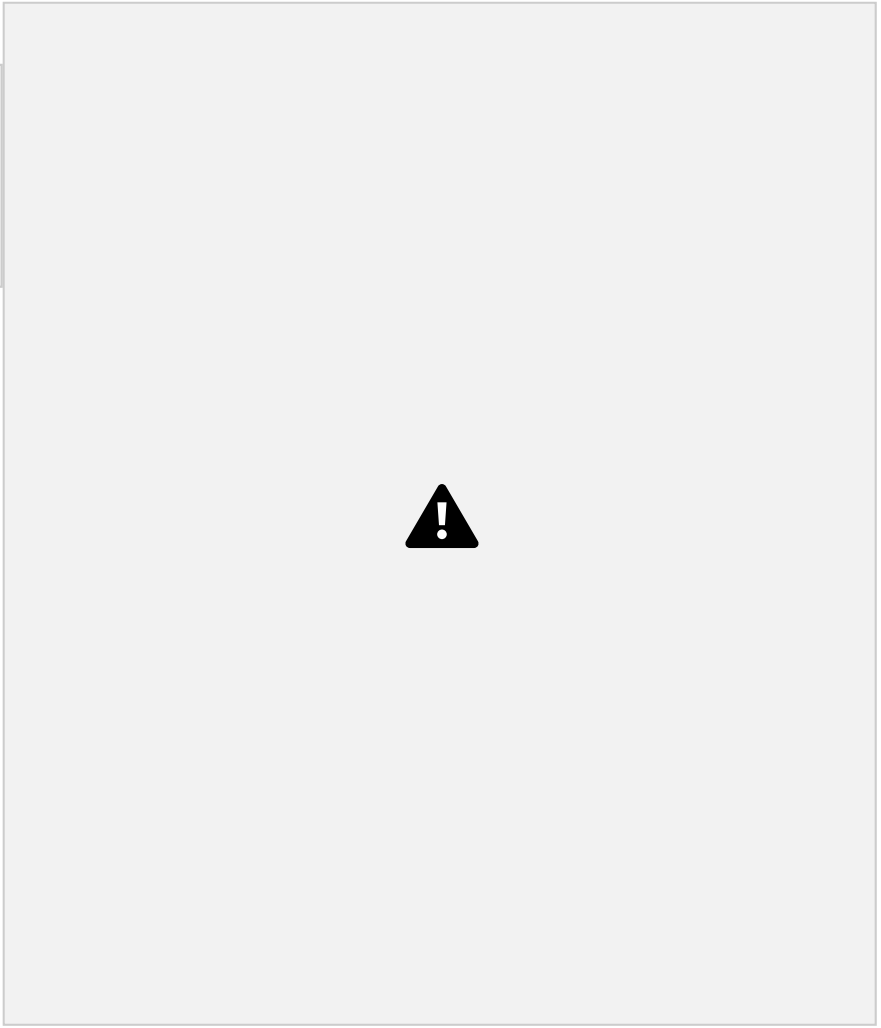
s

Part 2 of Coach's Clinic

Building

- Weight is EVERYTHING
  - Glue control
    - Thin CyA
    - Capillary applicator
  - Balsa Density
    - Weigh and grade balsa
    - Bring scale to store
    - 5-8 lb/cu ft is “contest grade”
    - Heavier wood may be used, but limited
    - Kits have excellent wood
- Straight
  - Use fixtures
    - Foam board allows pins
  - Glass or shelving surface
- Strength





- Wrap key joints with thread, dot of CA
- Carbon is light, stiff

Covering

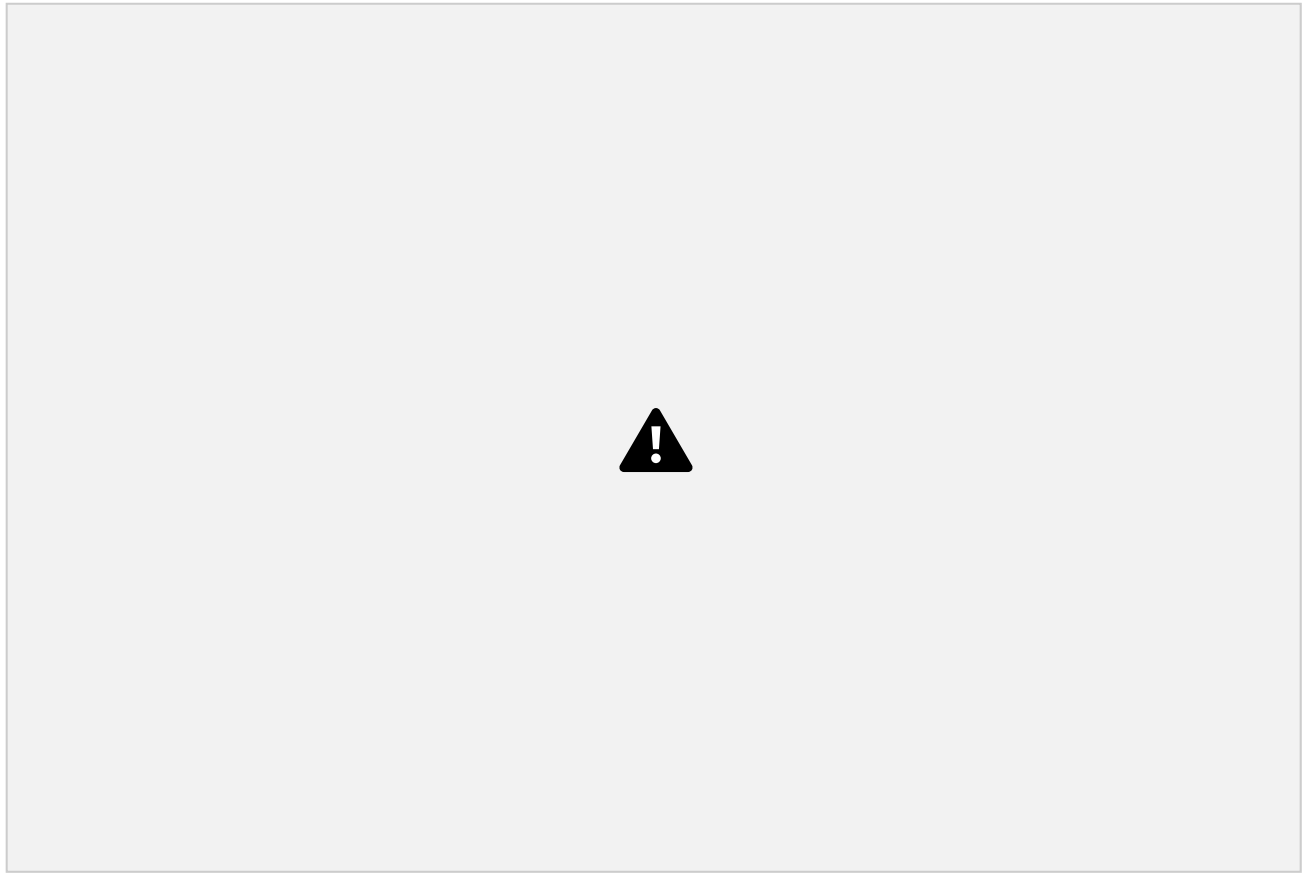
- Ultrafilm is used in most kits
    - Grocery veggie bags an excellent alternative
- Prepare
    - Build structure
    - Build a frame scrap balsa. Frame may need twist
      for Heli
- Film
    - Cut with solder iron if available, tears easily
    - Ball up as small as possible, twice
    - Unfurl with outward stretching motion
    - Attach to frame with lip balm or Vaseline
    - Carefully stretch to edges, not tight
- Adhesive
    - 3M 77 is best (easy, light enough)
        - Glue stick an alternative
    - Light coating on top of structure separate from covering
    - Press into framed film inverted



Flying Techniques

Flying Basics

- Far fewer variables than airplanes
  - CG location. Try ballast at top, at bottom, see what works best
  - Changing rotor pitch may require new rotor
- Rubber
  - Width, or preferably "Linear Density" (g/in)
  - Overall mass
  - Overall length (before tying)
- Winding
  - Generally back off peak torque only enough for motor stick safety
  - Wind to near max turns for given rubber
    - Max turns calculator on NFFS website



Rubber optimization ·

Two-parameter optimization

- Rubber width
- Rubber mass or length

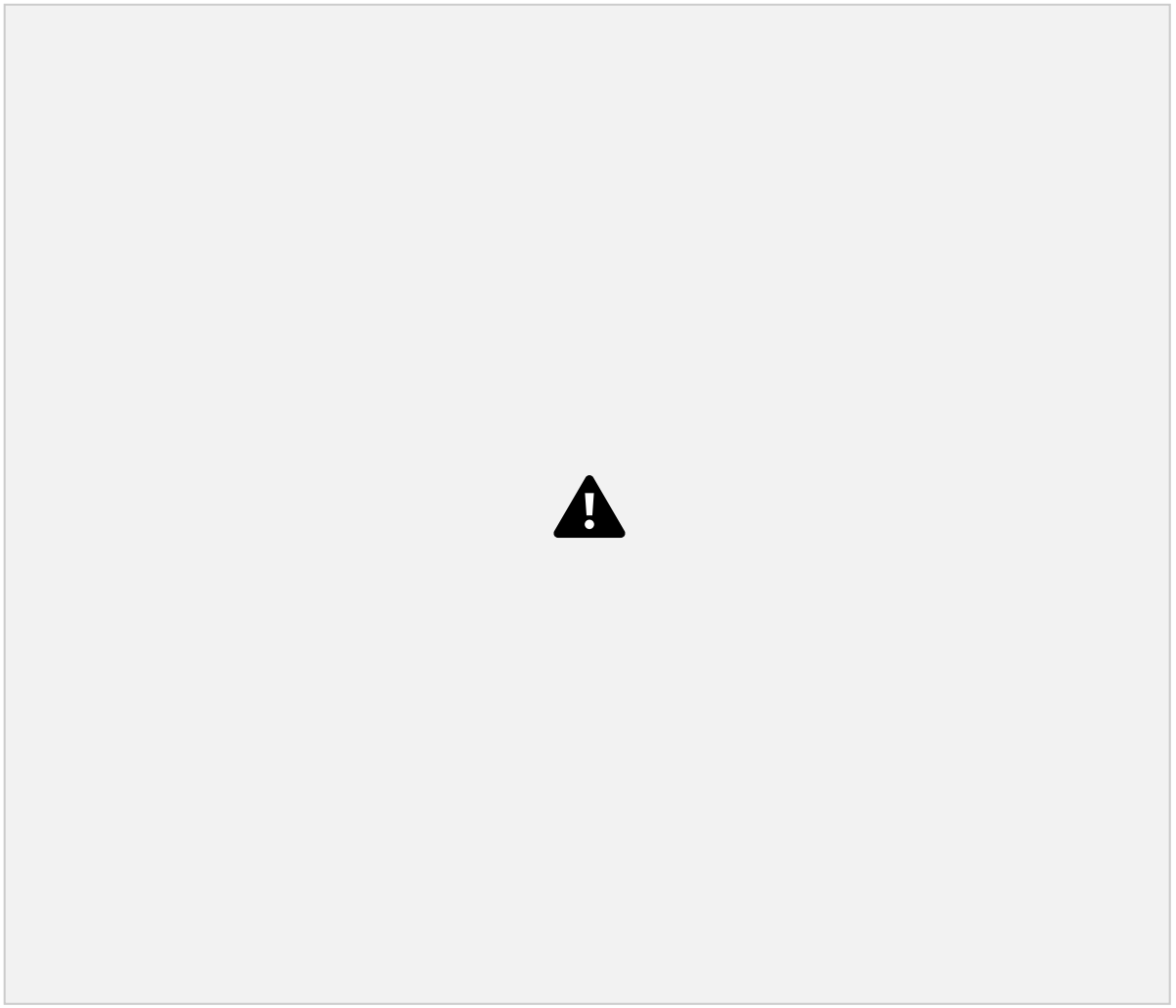
- Fix one parameter (width) and vary the other (length or mass) to find optimum (stopwatch)
- Adjust fixed parameter and repeat
  - Note: if you only have one rubber width available then optimize the mass or length only
  - Stock rubber width may vary in linear density due to thickness variations
- Optimum
  - Max time on the watch 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 TESTTEST
  - 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



Warnings for 2025

- Large rotors mean large rubber
  - Higher torque
  - Higher energy
- Safety
  - Strongly consider eye protection
  - Consider gloves
- Equipment
  - Reports of IFFS/Guega winder gear breakage at 2.0oz-in torque
  - 10:1YellowWinder appears suitable. 15:1 may be hard to turn at high torque
  - Many torque meters will not reach 2.0 oz-in. More than one full turn on wire element may permanently damage element

- IFFS will carry new larger element for 2.5oz-in •

Rubber installation

- Try using hemostats to transfer rubber



Flying

- Rubber winding
  - Hysteresis
  - Wind off aircraft!
  - Torque meter
  - Wind counting
  - Lubricate
    - Silicon oil
    - Armor-all
  - Wind to almost breaking (break some to know) •
    Usually based on torque
- Stretch winding
  - Stretch to 5-8X length

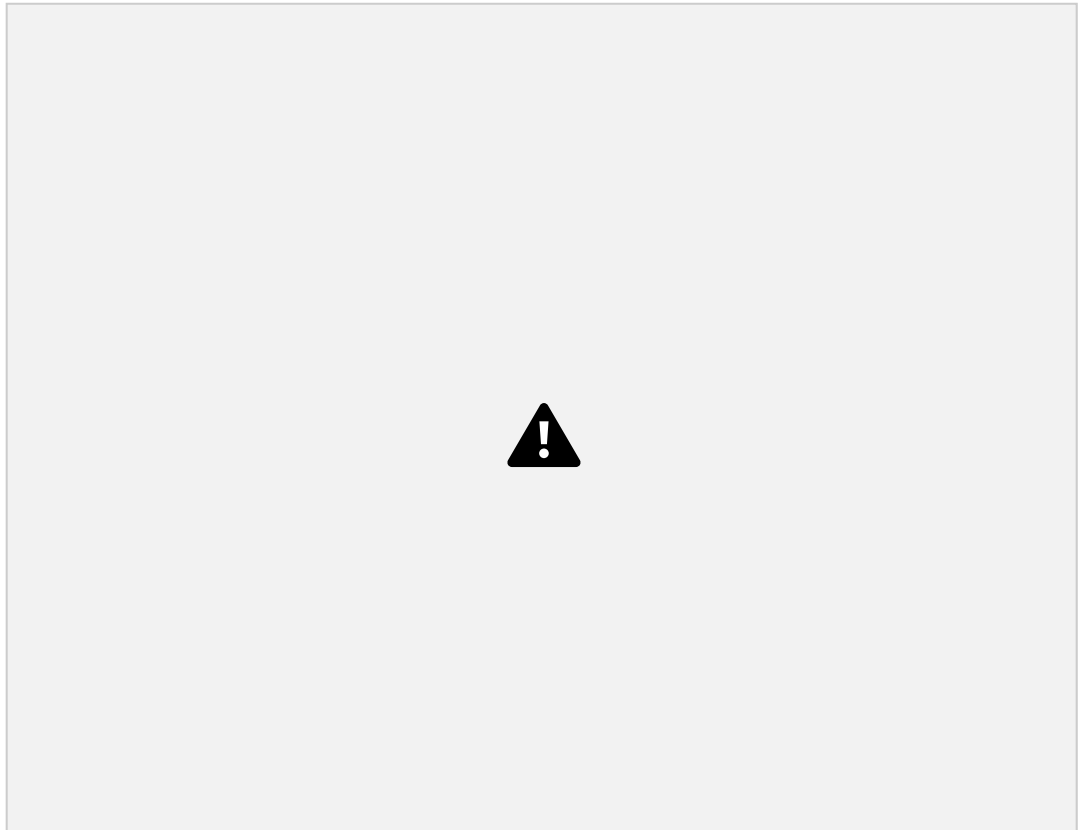
- Wind ½ at full stretch, then walk in



Rotor Adjustments

- Rotor pitch is generally built in
  - X-rotor built in to basic structure
  - Flat rotor with carbon spar, built in when attaching blade to spar (J&H)

- Is less pitch better?
  - Two flight phases
    - Climb
    - Hover against ceiling
  - Lower pitch allows thinner rubber
    - However, too low may flutter and be ineffective in climb



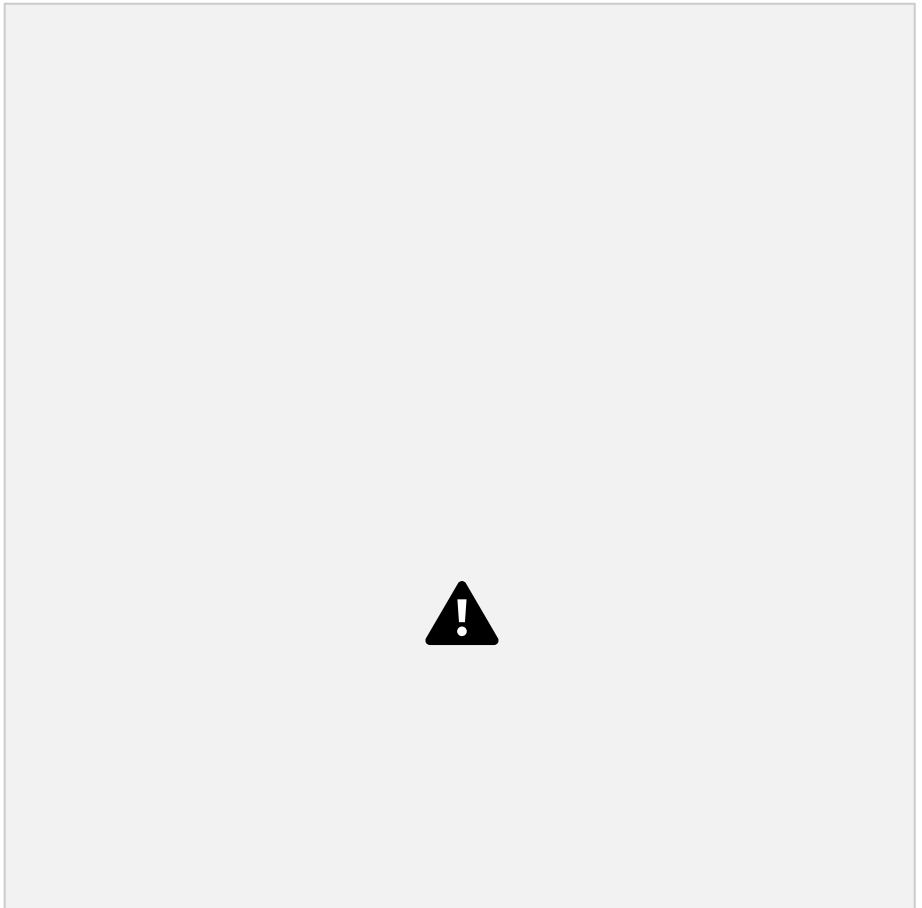
- Apparent angle of attack is lower while climbing, can even go negative

- This is a parameter for advanced development!
  - Costly in time and materials



Advanced Development

- Rotor configuration
  - Coaxial or Chinnook
  - Number of blades
  - Blade shape
  - Blade pitch progression
  - Chord
- Motor stick
  - Hook to hook length, mass vs. rubber size
  - Bracing vs. balsa cross section
- Rubber



• Fine tuning of rubber linear density (width and thickness) • Winding technique

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

Follow-up

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

Official rules clarifications are thorough the SO FAQ process ONLY