Science Olympiad Flying Events

Chuck Andraka

Coach, Albuquerque Area Home Schoolers

Credentials

- MSME Virginia Tech, 1984
- R/C model aircraft lifelong hobby
- SO coach flying events
  - 2016:WS
    - 1st Region
    - 1st State
    - Top 10 Nationals
  - 2017:WS
    - 1st Region
    - 1st State
  - 2018:WS
    - 1st Region
    - 1st State
    - 2nd Nationals
  - 2018: Heli
    - 1st Region
    - 1st State
    - 1st Nationals
  - 2019:WS
    - 1st Region
    - 1st State
    - 1st Nationals
  - 2019: ELG
    - 1st Region
    - 1st State
    - 3rd Nationals
  - 2019 Co-ES NM State
  - 2019 coach 2 members of US Junior F1D team, plus alternate
    - 3 new National Records
- Home School Parent 4 kids

Presentation Order

- Event descriptions and rules
  - Elastic Launch Gliders B
  - Wright Stuff C
- Sources of materials and aid
- Building techniques
- Flying

Elastic Launched Gliders B

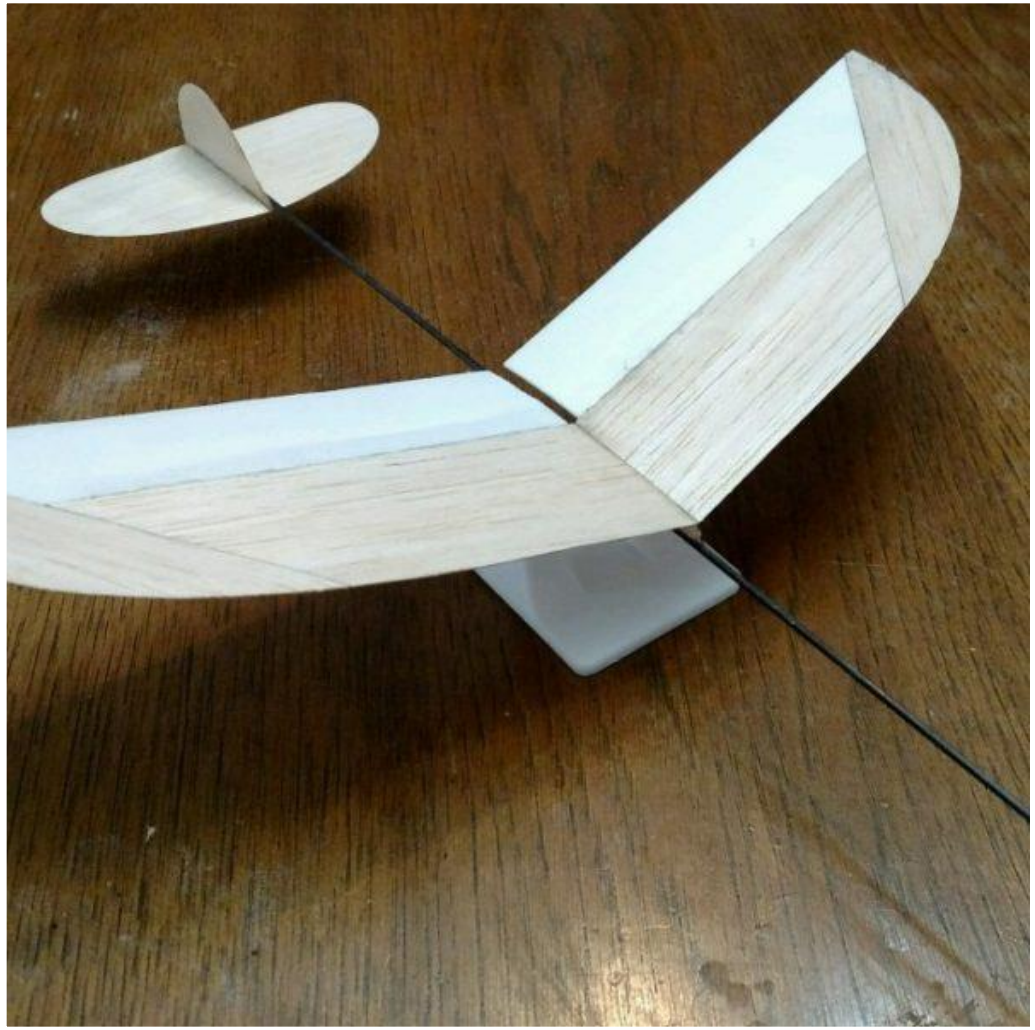
Indoor Glider Duration

ELG Event Description

- Prebuild event
- Unpowered glider made from wood, foam, paper, plastic film, carbon fiber, tape, thread, glue
- Launch with non-metallic elastic
- Fly 5 flights for duration, best three flights sum for score

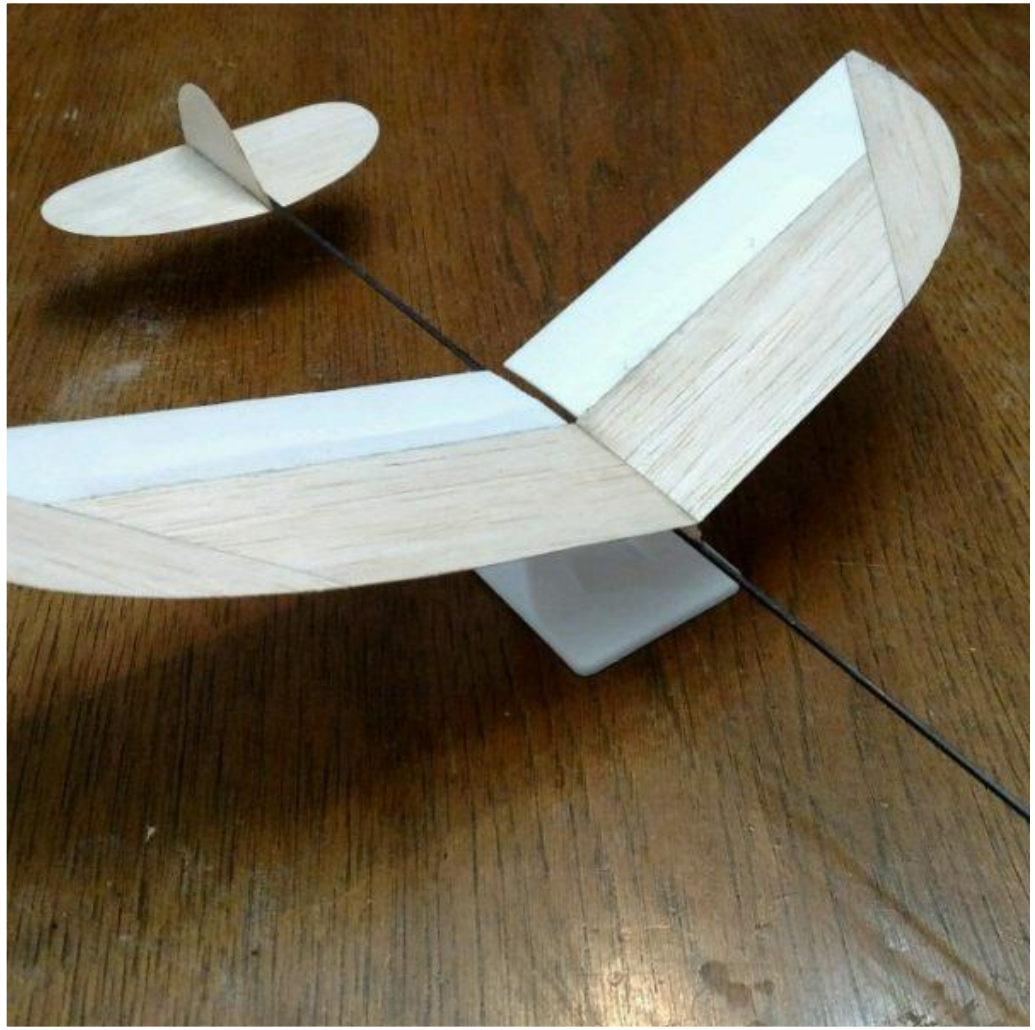
ELG Event Parameters

- Kit, plans or self-design
- 28cm wing span
- 3.0 to 10g
- Blunt nose larger than lip balm cap
- 10% bonus for fuselage > 32cm
- 10% bonus for first flight within 1 minute
- 25% bonus for canard configuration
- Labelled for identification
- Non-metal ballast
- Up to 2 planes presented for inspection
- Launcher
  - Elastic must remain attached
  - No dimension greater than 1m except stretched elastic
  - Supported by one student during launch
- Eye protection level B: Z87+ marking
- 2-Student team
- *Rubber bands are not an allowed construction material*



ELG Event Parameters NOT MENTIONED

- Wing Chord
- Stabilizer size



ELG Event
Flying Process

- Indoors, with room dimensions published in advance
- No coaching or communication once in event
- ONLY PARTICIPANTS may touch plane. This means DO NOT let officials attempt to measure
- Flight log: 30% penalty if not presented
- Launch handle and plane supported by <u>one student</u>
- Trim flights permitted, but on the clock, and <u>must</u> be announced as trim
- Must launch at ceiling
- Clock
  - 5 minute period starting with first flight, trim or official or end of preflight time period
  - 1 minute prep period, starts when student picks up a plane. 10% bonus if start in 1 minute window.
  - No time-out for retrieval or repairs
- Score sum of 3 best out of 5 official flights, plus bonuses
- Construction violations are tiered

ELG Event Log Book

- Log books are critical to learning, trimming, improving
- Missing log book 30% penalty
- Incomplete log book 10% penalty
- Required entries
  - Flight peak height (estimate or measure)
  - Elastic relaxed length
  - Flight Time
- One additional minimum column
  - Launch angle
  - Launch tilt
  - Elastic cross section
  - Flap stiffness
  - CG
  - Any other
- 10 flights minimum

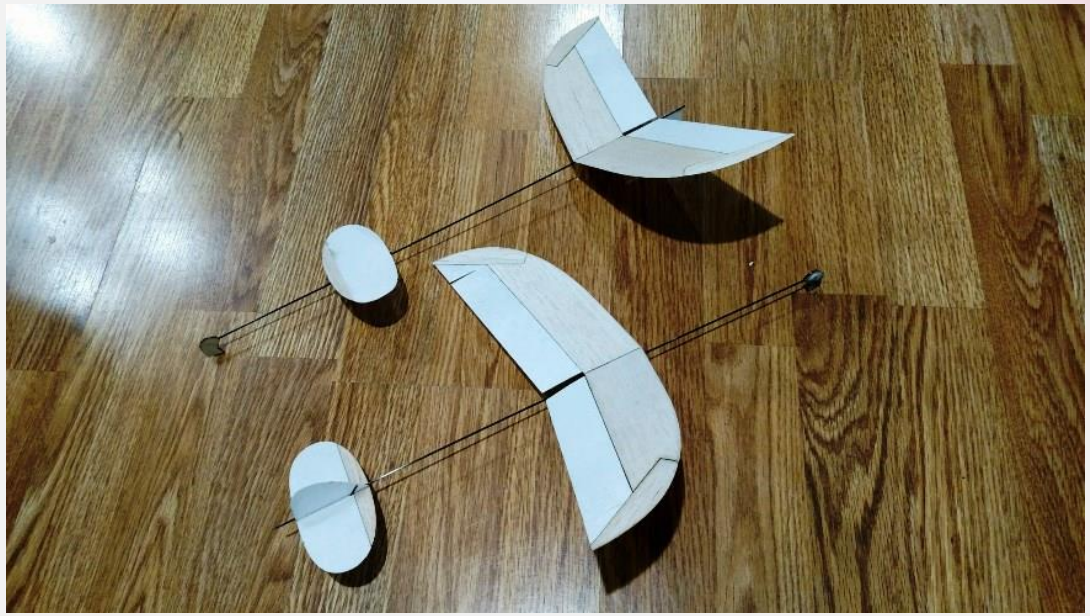
AAHS ELG Log 2018-2019														
Date	Flight	Plane	CG behind LE (mm)	TE Shim Height(mm)	Left Flap Stiffness (g)	Right Flap Stiffness (g)	Rubber length (cm)	Rubber width (g/in)	Rubber stretch Length (in)	Angle Launch (deg)	Tilt Launch (deg)	Duration (sec)	Altitude (ft)	Notes

2019 Issues and Observations

- Insufficient Logs
  - Only 10 entries (or less)
  - Too few columns
  - *Logs are a critical element of improvement*
- Wingspan did not meet spec
  - Many FFM planes exceeded allowable wingspan by up to 1cm
  - Usually caused by not enough dihedral
  - *Measure before competition*
- Crooked construction
  - Accurate construction is critical
- Untrimmed models
  - Basic glide
    - Center of Gravity
    - Wing incidence
  - Launch
    - High speed launch requires additional adjustments
    - J&H videos
- Most planes reasonably built, but not reasonably trimmed

2020 Thoughts

- Spend more time in gym than in build
- Keep detailed logs
- Skip the Canard
  - Word is that it is VERY hard to trim
  - Get SOMETHING flying
- Anything that *glides* will be very competitive
- Very good online videos on trimming at J&H



Wright Stuff C

Indoor Rubber Powered Duration

Wright Stuff Event Description

- Prebuild event
- Rubber powered free-flight
  - Monoplane or Bi-Plane
  - Any materials except Boron
  - Student-built
- Best of two flights duration

Wright Stuff Event Parameters

- Kit, plans or self-design
  - No pre-glued or pre-covered
- 30cm wing span, 8cm chord
  - Monoplane or bi-plane
- 12 cm stab span, 6cm chord
- 8cm diameter prop
- 8g minimum
- Propeller built or purchased
- Rubber powered
- 10% bonus for BLACK MARKER between 2 ribs or one tip plate
- Labelled for identification
- Up to 2 planes presented for inspection
- 2-Student team
- Non-compliant planes tiered

Wright Stuff Event Parameters NOT MENTIONED

- Plane configuration
  - Canard
  - Conventional
- Rubber mass and size
- Length of plane

Wright Stuff Event Flying Process

- Indoors, with room dimensions published in advance
- No coaching or communication once in event
- ONLY PARTICIPANTS may touch plane. This means DO NOT let officials attempt to measure
- Flight log: 30% penalty if not presented
- Trim flights permitted, but on the clock, and must be announced as trim
- Clock
  - 8 minute period starting with first flight, trim or official, or end of preflight time period
  - Trim flight may be unpowered
  - 3 minute prep period, starts when rubber handed to student. 5% bonus if start in 3 minute window.
  - No time-out for retrieval or repairs
  - Flight starting in 8 minutes may go to completion

Wright Stuff Event Flying Process

- Score best duration of 2 official flights, plus bonuses
- BONUS:
  - If SAME PLANE is used for both flights, including ALL components except rubber
  - If plane makes full circle (360 degrees) to left on one flight, to right on other flight
  - Then score is SUM of both flight times
  - This bonus becomes almost mandatory for good score!
  - No room for "safe" vs. "all out" flights
- Construction violations are tiered

Wright Stuff Event Log Book

- Log books are critical to learning, trimming, improving
- Missing log book 30% penalty
- Incomplete log book 10% penalty
- Required entries
  - Motor size (length, width, mass)
  - Number turns or torque AT LAUNCH
  - Flight Time
- Three additional minimum column
  - Altitude
  - Torque
  - Remaining turns or torque
  - Unwinds
  - Propeller details
  - Any other
- 10 flights minimum

AAHS Wright Stuff Log 2018-2019

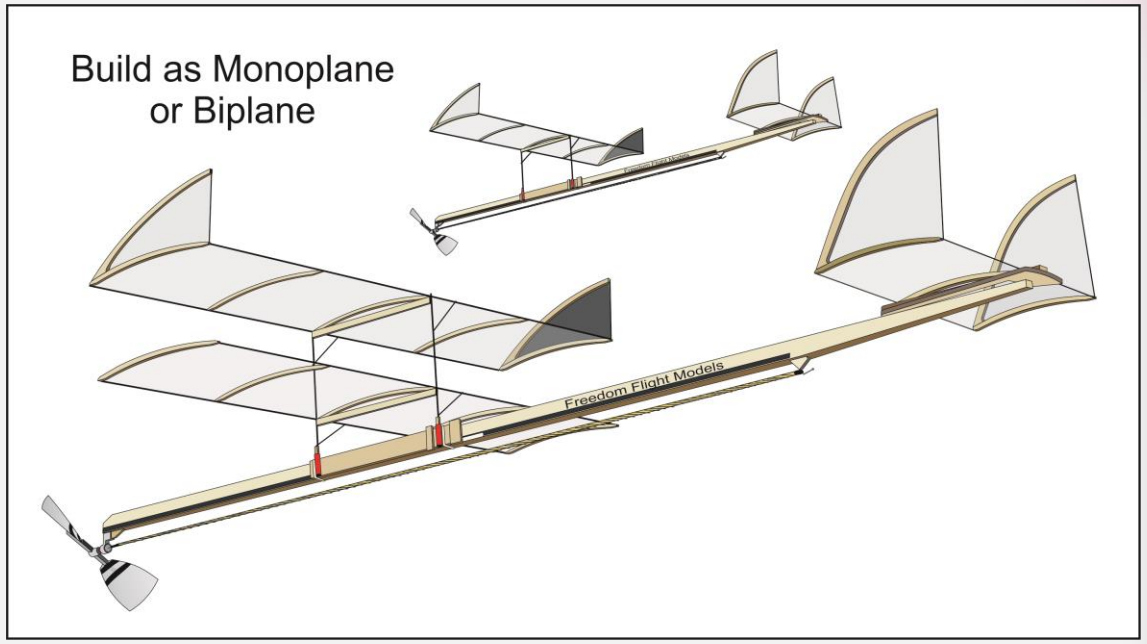
Date	Flight	Plane	Propeller	Prop Pitch	Prop Flex (g)	CG behind TE (mm)	LE Height (mm)	TE Height (mm)	Stab LE height (mm)	Stab TE height (mm)	Rubber length (cm)	Rubber width (g/in)	Rubber mass (g)	Number Winds	Number unwind	Net Winds Launch	Torque Max	Torque at Launch	Duration (sec)	Altitude (ft)	Turns Remianing	First lap altitude	Notes

2019 Issues and Observations

- Insufficient Logs
  - Only 10 entries (or less)
  - Too few columns
  - *Logs are a critical element of improvement*
- Crooked construction
  - Accurate construction is critical
- Untrimmed models
- Most planes reasonably built, but not reasonably trimmed
  - Need to do a circle for any reasonable duration
  - Trim plane for low power, then work on higher power adjustments
  - Bonus this year REQUIRES field adjustments
- Not flying the same in practice and competition
  - Do not let observations of others change your approach!

2020 Thoughts

- The Stab is very small, which will make trimming difficult
  - Small adjustments to CG will be important
  - Err toward nose-heavy
- The Prop is VERY SMALL
  - Energy management will be hard
  - Vary prop area, pitch to match rubber
- Rubber will be VERY THIN
  - Lots of winds
  - Time management will be an issue
- 2-flight bonus will be critical
  - Figure out plane in left circle first
  - Develop repeatable trim for both directions
  - PRACTICE
- Flights will be substantially shorter this year



Sources

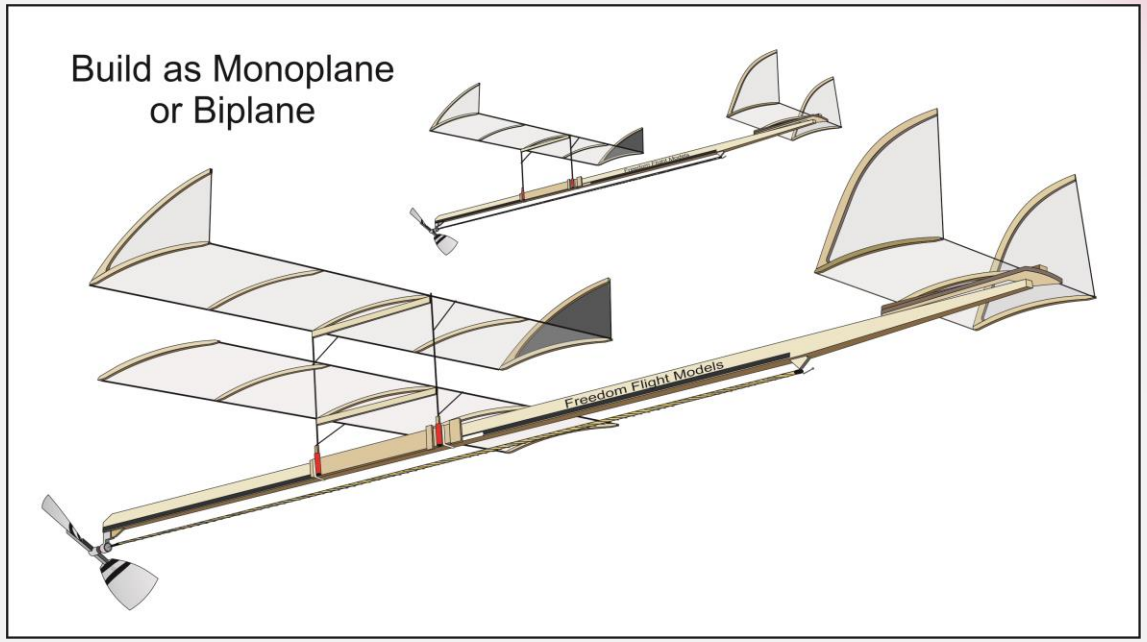
Kits

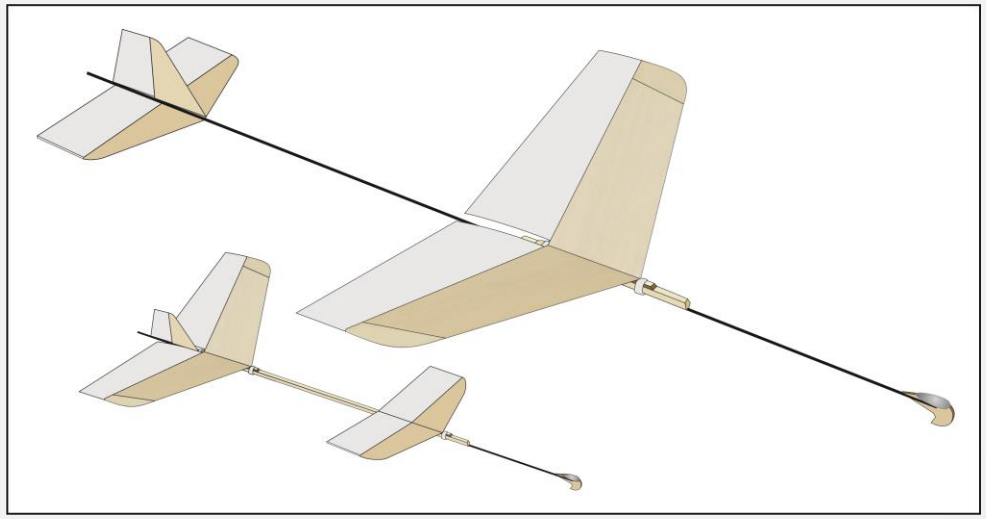
Supplies

Help

Kits

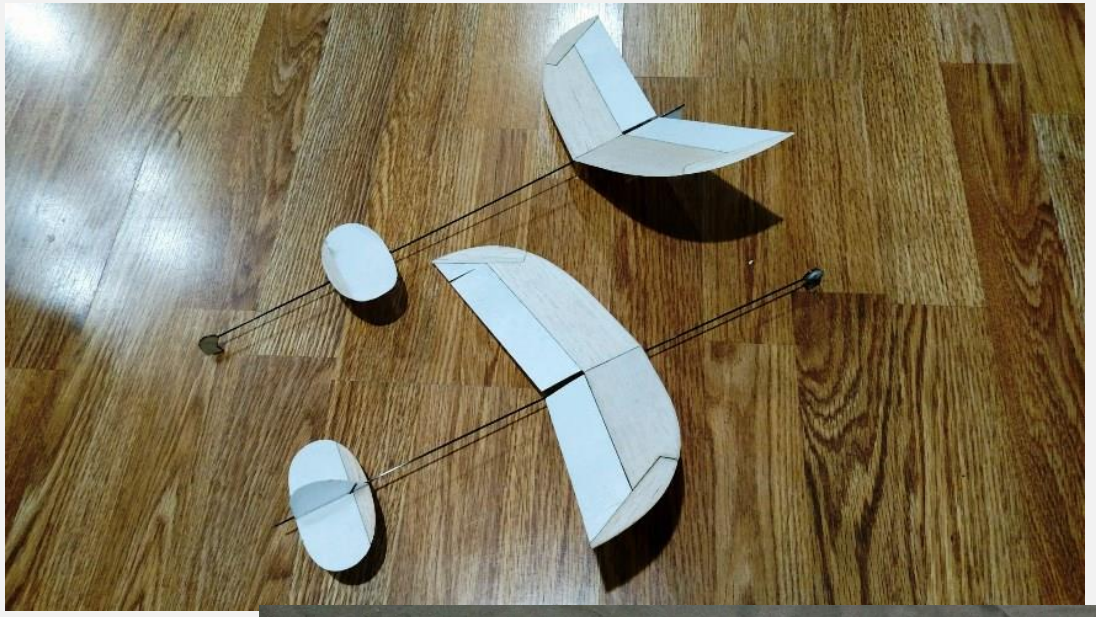
- Freedom Flight Models
  - Complex
  - WS Competitive, consistently in top 10 at Nationals
  - *2019 Gliders were NOT competitive, but design has changed*
  - Consistent quality
  - EXTENSIVE instructions
  - 4 gliders, $67
  - 2 planes, $64
  - https://www.freedomflightmodels.com
- Also a full stock of accessories
  - Torque meter
  - Winder
  - Counter
  - Rubber
  - Propellers
  - Launcher for ELG





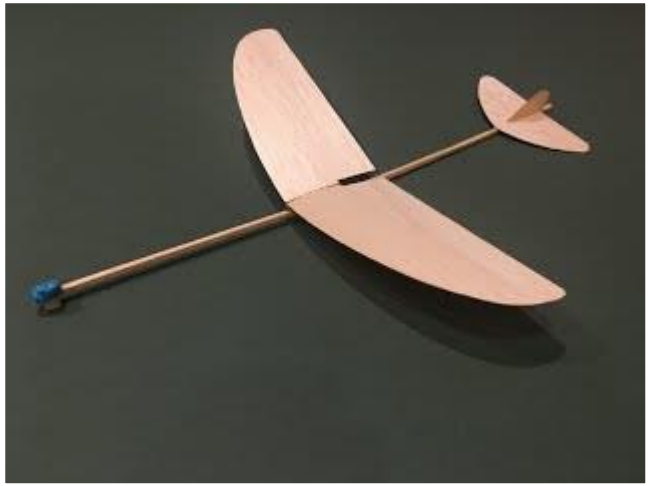
Kits

- J&H Aerospace
  - Competitive indoor flyer designs
  - Proven glider results
  - Many good YouTube videos
  - Protégé Flapper glider (3), $40
    - Builds as Canard or Standard
  - Senior Flyer plane (3), $65
    - Laser cut, interlocking parts
  - https://jhaerospace.com/



Kits

- Guru Engineering
  - Second Year
  - Based out of WV, supported WS win at Nationals 3 years ago
  - Non-profit
  - Lowest cost options
  - Guru Glider Kit ’20 (4), $33
  - Guru Propeller Plane Kit ‘19 (2), $33
  - http://main.guruengineeringtech.com/

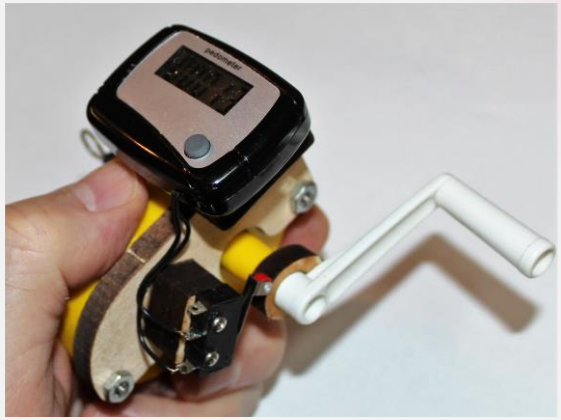


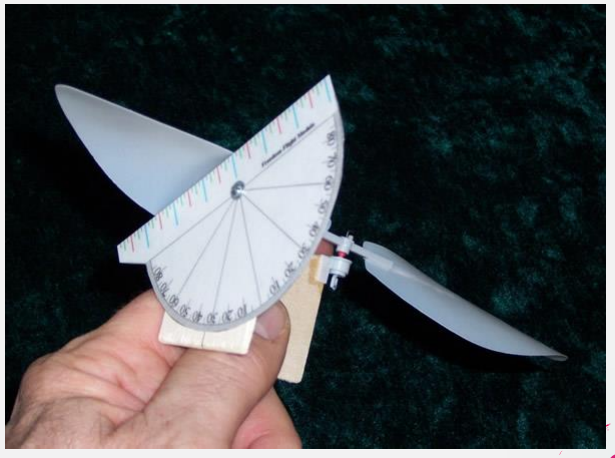
Kits

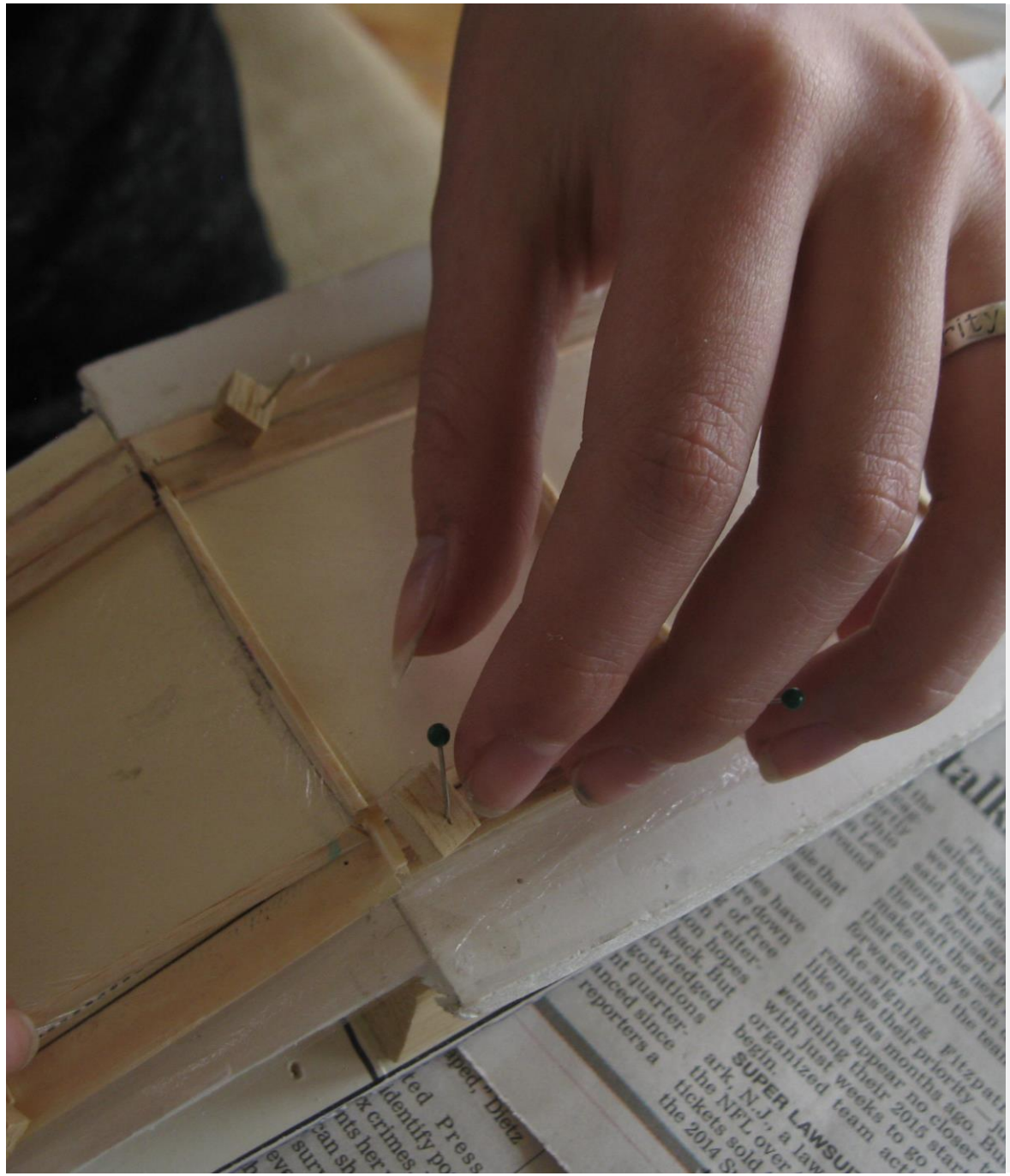
- Laser Cut Planes
  - Simple building
  - Operable design
  - Low cost
  - Photo-instructions, no plans
  - Limited propeller effectiveness
  - Wright Stuff only
  - Sci O'Relief Kit, $19
  - https://lasercutplanes.com/
  - Known for simple assembly

Accessories

- Rubber, Props, Winders, Torque meters, covering
  - Freedom Flight Models
    - https://www.freedomflightmodels.com
  - FAI Model Supply
    - https://www.faimodelsupply.com/
- Covering, prop hangers, rubber stripper
  - Indoor Model Specailties
    - http://www.indoorspecialties.com/
- Plans
  - Hip Pocket Aeronautics
    - http://www.hippocketaeronautics.com
    - Look for Bill Gowen and Brian Turnbull
- Online Resources
  - Hip Pocket Aeronautics forums
  - SCIOLY online forums
  - 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/ScienceOlympiad5.0.pdf







Building Techniques

Building

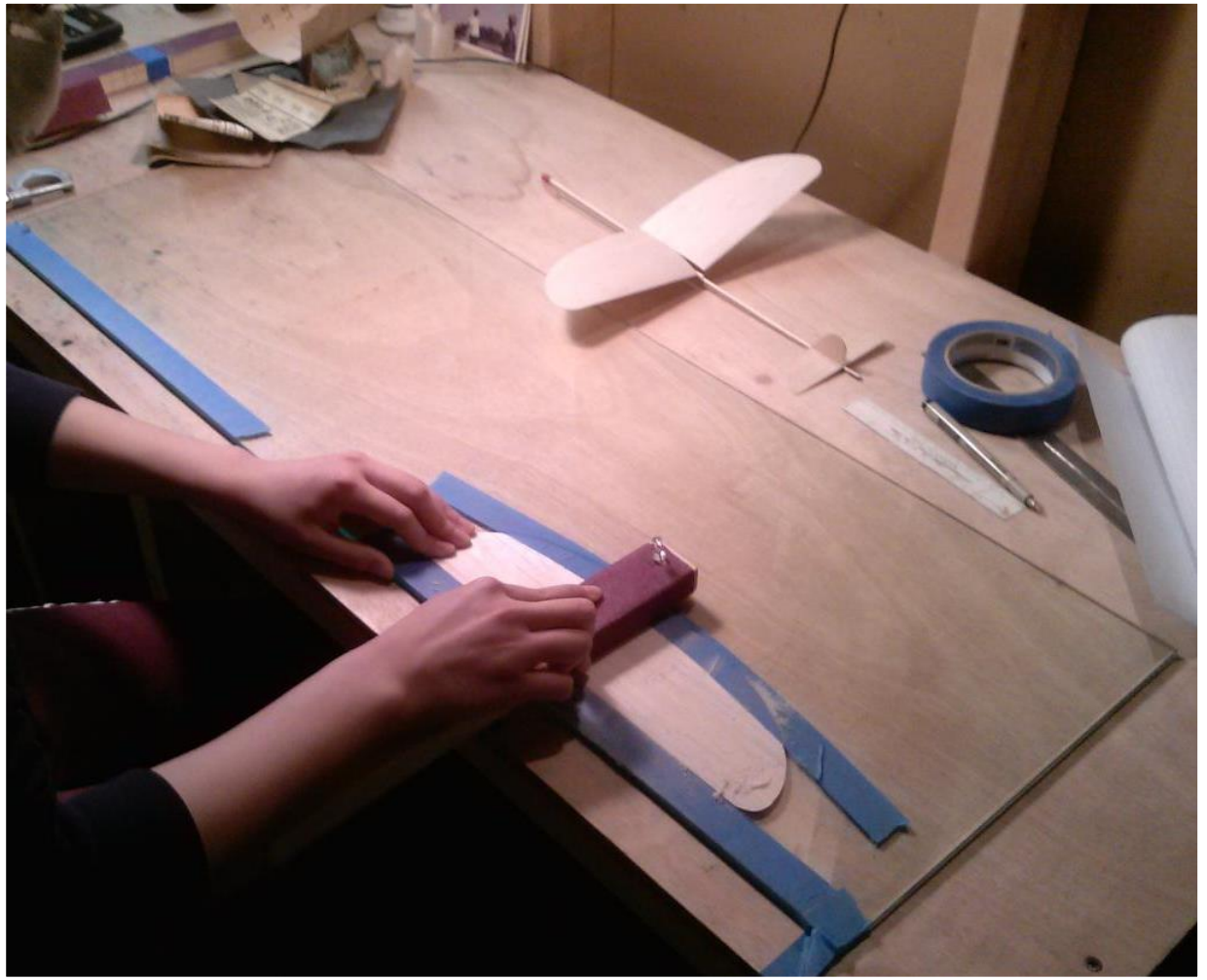
- Weight is EVERYTHING
  - Glue control
    - Thin CyA
    - Capillary applicator
  - Balsa Density
    - Weigh and grade balsa
    - Bring scale to store
    - 5-6 lb/cu ft best
    - FFM and J&H kits have excellent wood
- Straight
  - Use fixtures
    - Foam board allows pins
  - Glass or shelving surface
- Strength
  - Wrap key joints with thread, dot of CA
  - Carbon is light, stiff

Covering

- Ultrafilm is used in most kits
  - Grocery veggie bags a decent backup
- Prepare
  - Build structure
  - Build a frame from Foam Board or scrap balsa
- 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
  - Carefully stretch to edges
- Adhesive
  - 3M 77 is best (easy, light enough)
    - Glue stick an alternative
  - Light coating on top of structure
  - Press into framed film
  - Allow to cure
  - Cut with soldering iron
    - Careful not to dwell on carbon

Glider Wings

- Key is sanding
  - Take time
  - Measure often
- Blue tape used for thickness guides
  - 1 layer about 0.005”
  - 4 layers for trailing edge
  - 1 layer on high spot
  - 5 layers on sanding bar to make 0.025” tail surfaces
  - Some kit surfaces are foam, no sanding
- Consistent balsa
  - Look at wood in light for consistent grain
  - C grain best for tails, LE
  - A grain best for flaps (or foam)



Flying Techniques

Gliders
Trimming

- Verify mass
  - Check often, remove ballast as glue is added
  - Use modeling clay
- Verify CG (often)
  - Typically 33-40% of chord, see plan
- Toss lightly
  - Like a dart, "place on air"
  - Adjust wing incidence for good glide
  - Adjust CG for small changes
  - Adjust tail tilt or rudder for **right circle**
- Elastic
  - Start slowly
    - Low angle
    - Low pull
    - Tilt to right
  - Increase angle and pull
  - Watch transition to glide
  - Take notes

Gliders Flying

- If anything changes, repeat trimming
- Vary launch angle while watching transition
  - How much does it drop?
- Vary tilt angle to improve transition
  - Stall and dive, tilt more to right
  - Fast, wide turn, tilt more left
- Vary pull to adjust altitude
- Log book!
- Each glider may behave differently
- Slight trim adjustments to improve glide
  - Nose down, too fast, move CG back
  - Stalling, move CG forward

Wright Stuff Trimming

- Verify mass
  - Check often, remove ballast as glue is added
  - Use modeling clay
- Verify CG often
- Decalage to about 5-10mm
- Wind lightly, 600 turns (60 on 10:1)
- Launch straight ahead with light toss
- Watch for stall
  - Increase wing incidence until stall observed
  - Decrease until stall just goes away
- Watch for recovery from touches (ceiling)
  - If dives, move CG forward and re-trim
  - If quick recovery, may try more aft CG
- Trimming may take one or more flying sessions

Wright Stuff Trimming (cont)

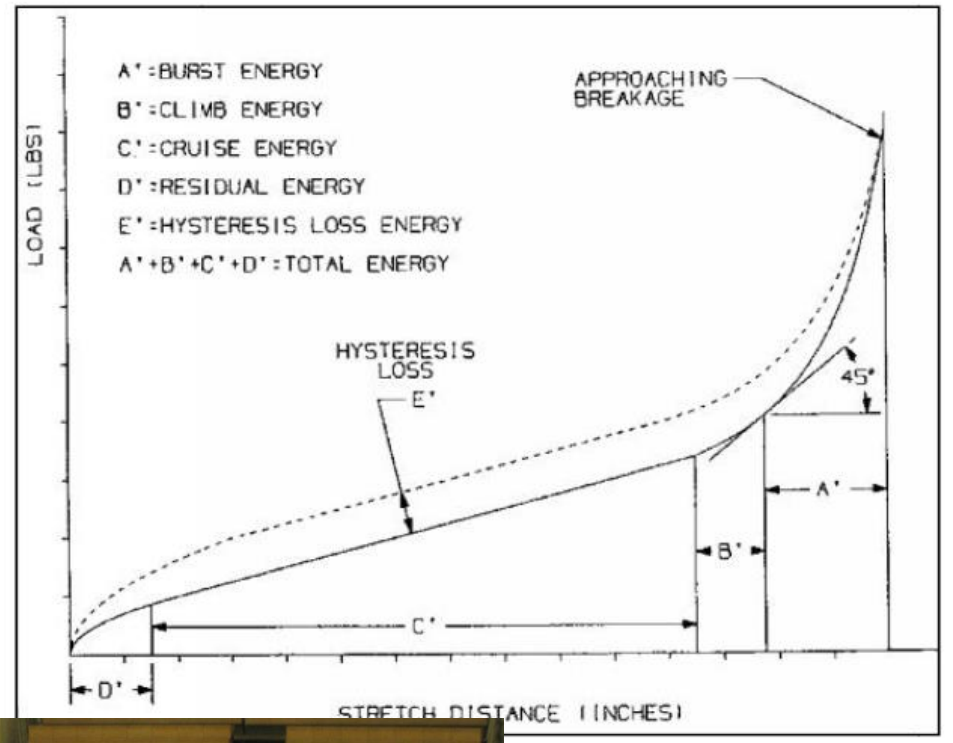
- Higher power launches
- Adjust launch torque to room height
- If roll in, add inboard wing wash-in (raise leading edge of inner wing)
- Rudder has greater effect on high speed
- Tail tilt has greater effect on low speed

Wright Stuff Flying

- Record ALL parameters in log
  - Change ONE THING at a time
- Rubber/prop optimization is key
  - Change props
  - Adjust prop (pitch, flex)
  - Rubber width, length
  - Stopwatch tells the tale
  - *If it won't climb, try thicker rubber, less pitch, or less diameter*
- Half rubber flights
  - ½ altitude, ½ time
  - ½ rubber length, same thickness
  - Predictable higher ceiling performance
  - Lower risk
  - Replace ½ rubber with weighted stick
- GET IN THE GYM
  - Winning takes 300+ flights

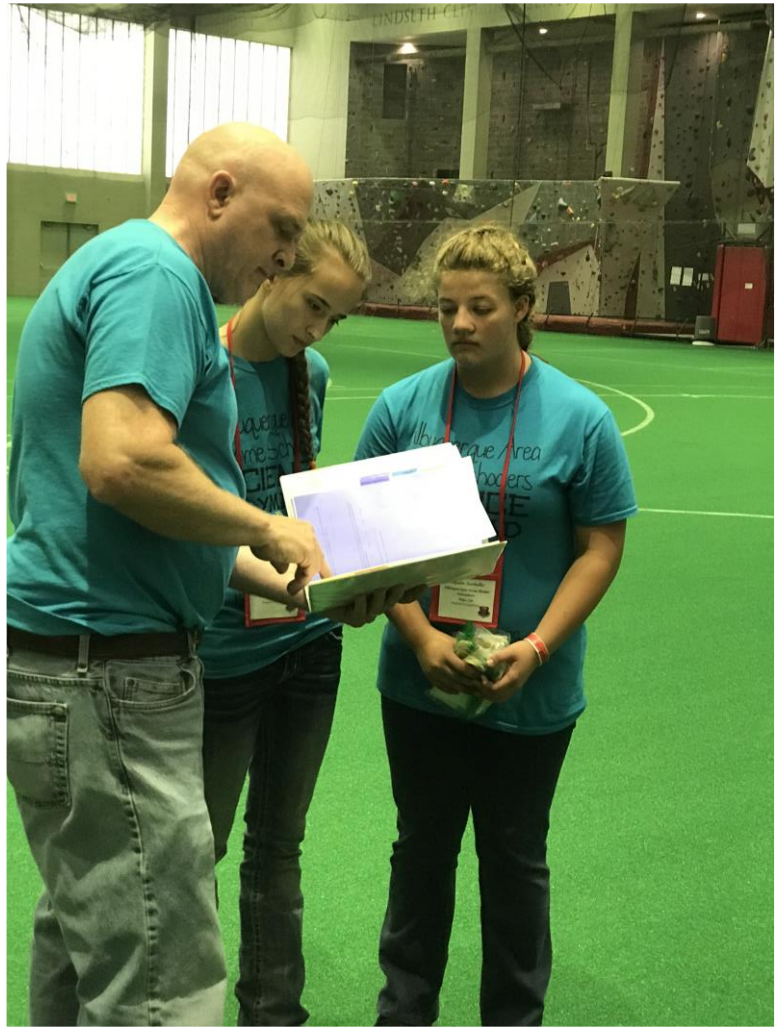
Wright Stuff Flying

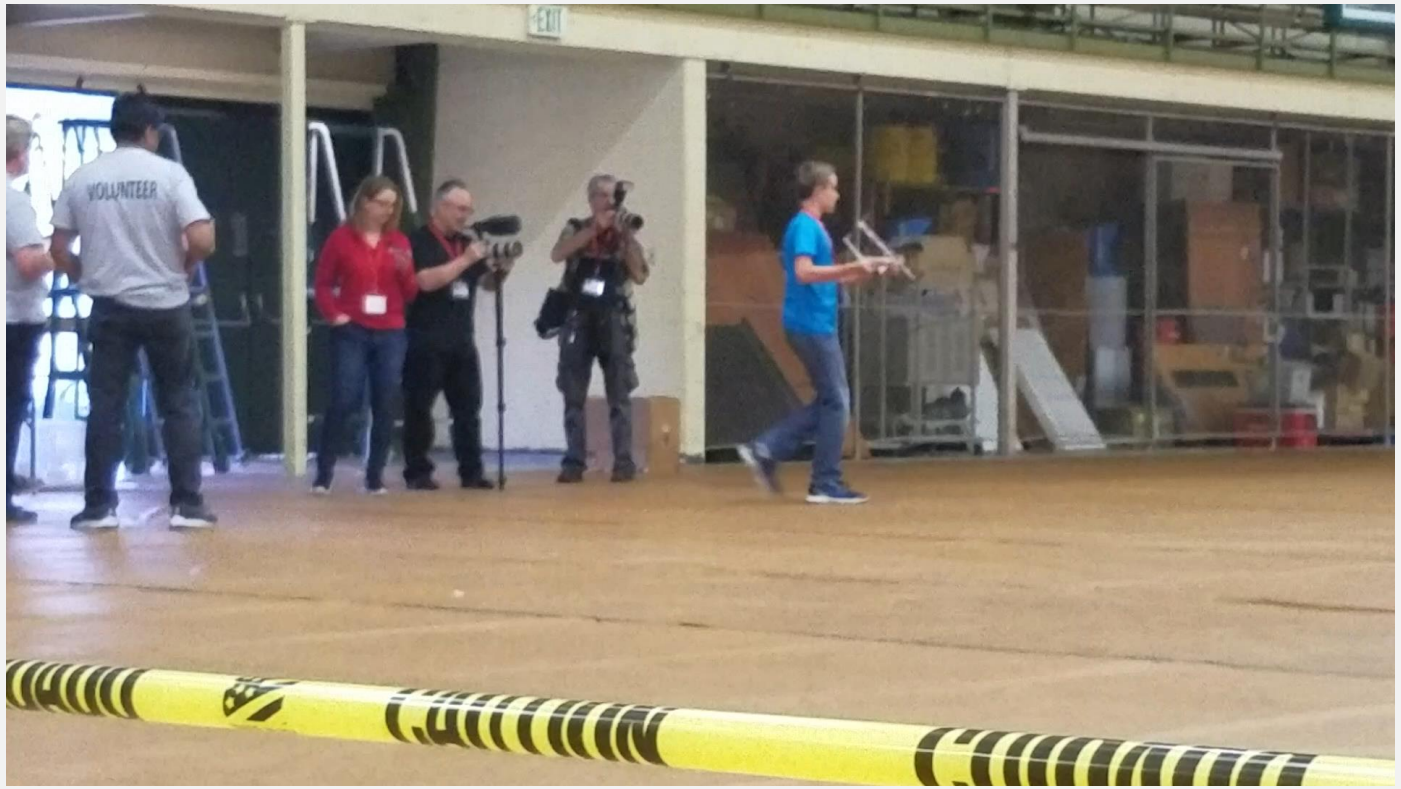
- Rubber winding
  - Hysteresis
  - Wind off airplane!
  - Torque meter
  - Wind counting
  - Lubricate
    - Silicon oil
    - Armorall
  - Wind to almost breaking (break some to know)
    - Usually based on torque
  - Back off to launch torque
    - Ceiling height
- Stretch winding
  - Stretch to 7-8X length
  - Wind ½ at full stretch, then walk in
- Rubber evaluation
  - Initial climb: Launch torque
  - Cruise: rubber/prop balance
  - Letdown: Prop flex
  - Look at turns remaining
    - Ideally about ½ row of knots



Flying Seminars

- AAHS team offering to provide in-gym hands-on trimming seminars
- December or early January time frame
- Separate for ELG and WS
- Need to set a time and location
  - Based on interest
  - Can your school provide a gym?
  - Rental gym available, but would require a fee
- Contact me for interest!
- Let's get your investment flying!





Follow-up

- ceandra@comcast.net
- (505)974-0380 (txt please)
- Can help in flying or building sessions