MAX FAX

Journal of the D. C. Maxecuters

... home of the dreaded POTOMAC PURSUIT SQUADRON of the Flying Aces

Editor: Stew Meyers 2014-3

Dan Driscoll's daugheter Kathleen holding his
Richard Morgan Small Cabin Model

RUBBER POWER ISSUE

COMING ATTRACTIONS

**INDOOR FLYING HAS RESUEMED AT BAUER
MON & WED 12;45 TO 2:15 PM SEE WEB SITE**

**JANUARY 18 2015 NATIONAL BUILDING MUSEUM
EVENTS TO BE SCHEDULED CHECK THE WEB SITE**

**MARCH 8 2015 NATIONAL BUILDING MUSEUM
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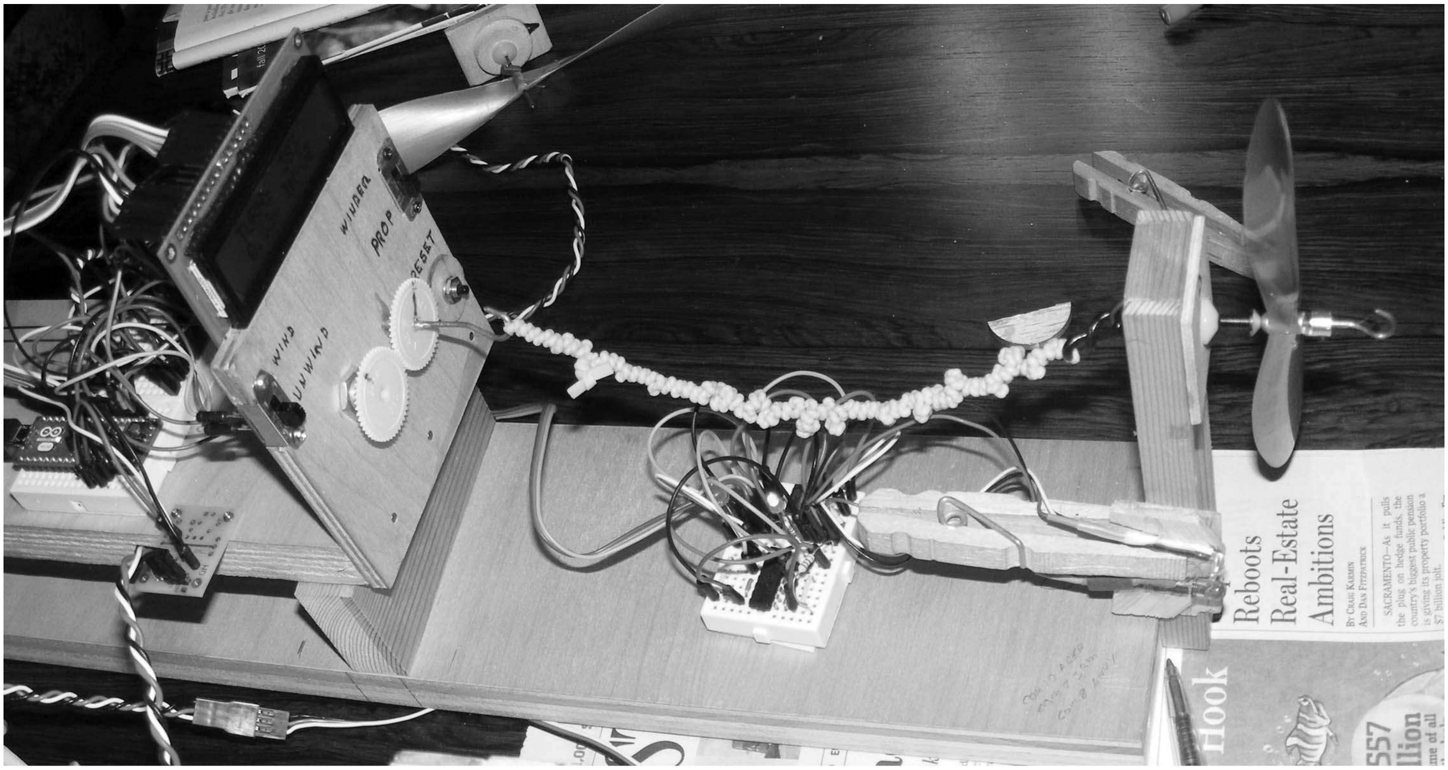
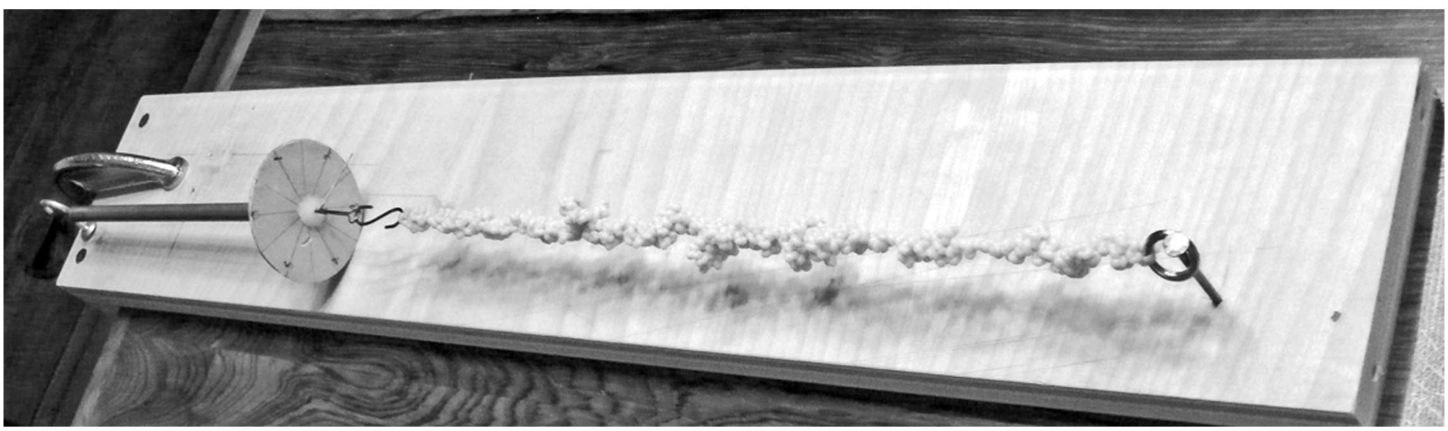


NO, THIS ISN'T A "SAG" TEST. IT'S A STOP ACTION SHOT OF A RAPIDLY SPINNING MOTOR WITH A LARGE STANDING WAVE. THAT "O" RING MAY HAVE CLIMBED OFF CENTER ON THE HOOK. THE PROP HAS FRONT LOOP TO MINIMISE INSERTION LOSSES OF TENSION & TORQUE.



NOW THIS IS "SAG" TEST OF A MOTOR ON A SIMPLE TEST RIG.
THE LOSSES ARE HARD TO SEE IN THE FIRST FEW MINUTES.

MORE VIEWS OF DAN DRISCOLL'S RICHARD MORGAN SMALL CABIN.

MaxFax 2014- 3

NOTE - WE HAVE GONE FROM BIMONTHLY TO QUARTERLY

Stew Meyers Editor

RUBBER POWER ISSUE

I know I just put out issue 2014-2 in October, but I need to put out an issue every month to catch up for this year. As you may know from the 2013-6 issue of MaxFax, I have been developing a recording torque meter (RTM) based on reading the angle of twist of a wire torque meter with an absolute shaft encoder and the number of turns with a counter on the winder. Thus when the current issue, #52, of the Free Flight Quarterly featured a couple of articles on rubber motor behavior, I was prompted to write a bit on it especially as applied to FAC flying.

Dan Driscoll provides us with his latest reincarnation of a vintage free flight model. On the cover, the picture of his daughter holding this model recalls covers of Flying Models & Model Builder. - A moment of silence for the deceased. I promote “Monkey Shit” ballast in lieu of messy clay. We have an useful article on trimming P-30's that is quite applicable to most FAC ships. This issue will focus more on how the RTM is configured and used and the questions it begs; the next issue will have a lot more real data and hopefully some answers. I also discuss “Sandbagging & Sag testing”.

Rubber Facts

Stew Meyers

The energy that we use to power our rubber powered models is stored as tension in the rubber strands. When the motor is wound, it is tensioned by twisting. There is a direct relationship between the torque and the tension in the motor. When tension is relaxed, the torque is reduced and vice versa. This can be easily demonstrated by watching the torque meter while varying the tension on a motor by stretching it to a different length with out winding or unwinding. We dump the energy out of a wound motor by letting it turn a prop. The torque goes down as the winds come out and the tension becomes less.

We can measure this energy. When one pound of force stretches the rubber by one foot, one foot-pound of work is done on it and is stored as energy. Dividing this energy by the weight (mass) of the rubber gives us the specific energy of the motor. This is used as a figure of merit (FOM) for the rubber. The usual units used are (FT-LB)/LB which devolves into Feet.

For a given volume of rubber there is a maximum stretch that can be applied before the rubber breaks. This is the absolute maximum energy that can be stored in the rubber motor. In practice the real available energy is considerably less.

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Your mailing label indicates the year and month of the last issue of your current membership. A red "X" in the box below is a reminder that your dues are due. Send a check, payable to the"D.C. MAXECUTERS", to the treasurer, Stew Meyers.

PUBLISHING DATES - Four issues of MaxFax are sent each year, one each quarter, but since this is a volunteer publication nothing is guaranteed except that four issues will be sent to all members. (***Rising costs and dwindling membership have forced us to go to four issues a year in 2014.***)

CONTACTS - Material for the newsletter and membership questions should be addressed to Stew Meyers phone 301-365-1749. Email gets immediate attention. stew.meyers@verizon.net

To determine what we can really do, we can integrate the area under the Torque-Turns graph. The “S” shaped hysteresis loop of the typical rubber motor being wound and unwound shows the losses that limit the amount of actual work (energy) that can be recovered from a wound motor. In the real world, there are further losses that come about from the loss of tension and therefore torque when the wound motor is attached to the prop shaft and the nose block is inserted back into the model.

My recording torque meter has allowed me to accurately plot the Torque-Turns graph for some typical FAC type motors. I am able to observe and record the behavior of rubber motors with much more resolution than is presented in “MYTHS”. The Torque-Turns graph is plotted in real time on an Excel spreadsheet. The unwinding of the motor driving a prop is also captured The unwinding of knots is readily discernable. I have also observed standing waves that sometimes set up in a rapidly unwinding motor. When the winder is used to unload the rubber motor this phenomena is rarely seen.

I am still figuring out how best to use the recording torque meter to characterize rubber behavior. What will happen if we vary this or that? In addition to comparing different batches of rubber, the effects of the number of strands for the same total width, braiding and hook length immediately come to mind. This will be particularly valuable in evaluating braiding and perhaps coming up with a good criteria for the number of braiding turns. It has already changed my winding procedures.

I will be happy to supply complete details of how to build the RTM rig and the programs used to those who would like to study the behavior of rubber motors in more detail.

Good Rubber Info

from

The Australian Free Flight Quarterly

The FFQ http://freeflightquarterly.com/ is an excellent journal that features in depth articles on various items of interest to the free flight world. (You Ludites out there can write Chris Stoddart 8400 Woodbrook Drive Knoxville TN 37919 USA for information on how to subscribe to print editions with out using the internet.) The latest issue, #52, contains two articles on rubber power that intrigued me. “Twist and Writhe” by Bob Morris, mathematically analyzing the process of knotting, and “Rubber Myths and Realities” by Paul Rossiter which brings up seven interesting and maybe somewhat counter intuitive observations that are of real practical use.

Here is his introduction:

“Ask any serious rubber flier about how best to select and prepare rubber motors and you will almost certainly get a list of do's and don'ts, some of which are recited as if written in stone. However, different fliers will often have a different set of rules! So in order to help navigate through this morass of information, let me state up front what, to within a percent certainty, my latest round of rubber testing has found in relation to rubber motors used in flying model aircraft:

- Lube type doesn't affect significantly the energy recovered.
- Washing the rubber doesn't affect significantly the energy recovered.
- A few broken strands don't significantly affect the energy recovered.
- The energy recovered is very temperature dependent.
- Breaking-in has no significant beneficial effect on the energy recovered.
- Ageing the rubber can either increase or decrease the rebound energy.
- Figure of Merit (FOM) testing should ideally be made at constant stress rather than constant load (or extension) and care is required in extrapolating the results to real flying conditions.”

First let me say, Paul Rossiter made up Coupe motors -10 grams of 1/8" rubber 120 inches long configured as 12 strands 10 inches long for his tests. Now 10 grams or 120 inches of 1/8" rubber is quite often used for FAC flying, but as 4 strands 30 inches long. That and the fact that the coupe motor is used with a ratio of rubber length to hook length of 1 and FAC use may have this ratio up to 3 and use braiding.

None the less these observations are relevant to FAC flying. Let examine them in turn.

1.- Lube type doesn't affect significantly the energy recovered.

Dan Driscoll ran some tests that confirm this observation. Silicon grease adds a little more weight which is a slight penalty for events with motor weight restrictions although it best preserves the motor. The liquid lubes may splash and coat the fuselage.

2.- Washing the rubber doesn't affect significantly the energy recovered.

No, but some rubber seems to have more than just talc on it. When you look at some of the particles washed out of rubber before making up a motor, you can’t help but wonder if they might initiate nicks.

3.- A few broken strands don't significantly affect the energy recovered.

Not on a 12 strand Coupe motor maybe, but they sure do on lower strand count motors. What this really says is the lubes don’t work that well and the broken stand can’t slip from the bundle.

4.- The energy recovered is very temperature dependent.

I’ll say. Warm motors can store and release more energy. Very cold motors can be stiff enough not to release all the winds. On cold days your motor will break at what you considered to be well below it’s peak.

5.- Breaking-in has no significant beneficial effect on the energy recovered.

No, it’s just another wind. If you wind close to max you can only do it so many times before nicks appear, why waste a wind or two.

6.- Ageing the rubber can either increase or decrease the rebound energy.

Rubber is a polymer that can lose plasticisers over time. Links may relax and align to produce more power. The real problem is elevated temperature storage will increase plasticiser loss.

7.- Figure of Merit (FOM) testing should ideally be made at constant stress rather than constant load (or extension) and care is required in extrapolating the results to real flying conditions.

As I detail elsewhere the real FOM for your rubber motor is dependant how much energy you can get out of it in the way you are using it. Paul Rossiter ’s approach is to integrate the area under the Torque-Turns curve.

“The motor was then unwound and the torque measured every 4 turns as rapidly as possible (verbally recording the results into a portable recorder) to 100-150 turns off and then every 25 turns to the end. The energy was then determined from the area under the torque vs. turns plots using Simpson's rule.”

Exactly what I do with my recording torque meter. Except, I use the trapezoidal rule rather than Simpson’s since I take data every turn when winding and every two turns when unwinding with a prop. The finer interval results in a good enough approximation of the area under the curve. The resolution of the Absolute shaft encoder is an order of magnitude better than you can eyeball off a wire torque meter disk. I do have to give Rossiter credit for thinking up a way to record real time data while both his hands were engaged in winding. (My earlier approach to this was to engage another person to write these down.) Exporting the data directly to an Excel spreadsheet from the recording torque meter is much easier than extracting it from a tape recorder playback. The enhanced resolution revels some very interesting phenomena and begs more than a few questions.

SIZING RUBBERS MOTORS

Gary Hinze
FF Mailing List forum

Sizing rubber motors is about balancing conflicting requirements. A rubber motor must meet all of several requirements:

Weight. Rubber is the source of the energy that lifts the plane. Duration is directly related to the amount of energy carried. So you would want the maximum weight of rubber you can get. But more weight also makes the plane come down faster. The duration trade off on weight occurs when the motor weighs twice the weight of the airplane. You will almost never get there, because one of the other requirements will restrict you to a smaller motor. In competition, rules will limit the weight of the motor to much less than this.

Length. A longer motor will take more turns for more duration. The motor must fit in the fuselage, it must fit between the propeller hook and the motor hook or peg. This may be the tightest limit on motor weight. You can make the motor longer than that distance, but only up to a point. You will find that when you get up around twice that distance, you will have troubles managing the motor. When you wind a very long motor and bring it in to fit between the hooks, it will ball up into a tangle. It will not unwind properly. It will jam on the stick or inside the fuselage. It will tangle all over the prop hook and jam it. Once it unwinds a little, it will hang down, no longer aligned with the prop shaft so it will not turn the prop. Braiding the motor will tighten it up a little and will allow you to get a little more rubber into the available space.

Cross Section. Cross section determines turns per inch capacity. Thinner motors can take more turns per inch, giving more propeller revolutions. Cross section determines torque. Greater cross section will produce higher torque values. A certain amount of torque is required to fly the plane. Torque required depends on the aircraft and propeller aerodynamics. Cruise torque, the torque to fly level, is a good indicator. In still air, cruise torque should occur at somewhat over half of maximum turns, maybe in the vicinity of 60% to 70%. (If you set maximum turns below breaking turns, cruise torque point should be reset.) The exact location depends on the shape of the torque curve for the particular batch of rubber used. (Or on the shape of the remaining curve if you set a maximum lower than breaking.) Cruise torque depends on the total weight, including the weight of the motor. Cross section is related to the other quantities because cross section times length times density equals weight. High torque also may produce undesirable rolling, which must be compensated with aerodynamic adjustments; dihedral, rudder, thrustline, aileron.

Center of Gravity. The plane must balance at a trim CG in order to fly properly. Motor weight and length affect CG. Motor CG will be at its midpoint. On a plane with a movable wing, the wing can be adjusted to accommodate different weights and lengths of motor. With a fixed wing, you may have no choice. Weight of motor will determine length or length will determine weight. It may be necessary to add ballast weight to accommodate the motor chosen. Ballast weight will increase the sinking speed. At some point, the added energy from a heavier motor will not overcome the added sink speed.

Structural Strength. The torque and tension in the rubber motor at full winds must be supported by the fuselage and appurtenant structures. A too strong motor will require strengthening the structures with corresponding weight increases. A weak structure will limit the size of the motor. Most of our model structures are pretty strong. This becomes an issue with ultralight indoor models.

Additional Considerations

Stew Meyers

Rubber Clearance. On some short nosed WWI models the braided motor becomes several times the hook length. I have found there may not be enough room to fully wind the motor. The rows of knots may climb the hook, touch the structure and jam stopping the prop. (Rather embarrassing during a mass launch.) If the model is picked up and the nose block extracted and reinserted in the model with fewer winds you get a normal flight. I could never wind my 18" Camel to more than 1200 turns despite the fact that 1600 turns were safe. It has a 5" hook length and used 24" of 1/8 x 4 rubber or a 15% rubber load. Ballasting considerations prevented using a higher percentage of rubber weight. Essentially the ballast weight was equal to the rubber weight. The solution might be to use a larger cross section and a larger prop. In any case, since then I have made a mock up of the fuselage for my WWI jobs to make sure the rubber will unwind properly and deliver the energy wound into the motor. You can check the unwinding motor for standing waves which can destroy structure as well as sap energy from the system. This also allows you to arrive at the correct number of braiding turns by experimentation. Offset “S” hooks and bent prop shafts that contribute to vibrations are also easily exposed with this set up.

Basic Starting Point. Weigh the model with everything but rubber to get the empty weight. Divide this value by 3 to get the weight of rubber for a 25% weight ratio. Divide the all up weight (empty weight + rubber weight) expressed in grams by 90 to get a suggested cross section width in inches. Now figure out the number of strands of various width rubber that will approximate this total width. (Draggy ships require larger widths than sleek jobs.) A 1.0 inch wide motor will weigh 8 grams per foot. So you can figure out how long the motor should be to match the desired weight.. Flight testing is required to really pin down the rubber - prop combination for your model. A good rule of thumb for max safe winding is 50 turns per inch of length for a 1” width of TAN rubber.

FLIGHT TRIMMING MODELS WITH FREE-WHEELING PROPS.

Fred Wilson, Beginner's Column Editor

(I don't know where this bit of sage advice came from)

I've been receiving requests for tips on flight trimming. This is another subject (like balsa wood) that cannot be covered in a single 800-1200 word column. This article will be limited to the flight trimming of rubber powered models with freewheeling propellers such as the popular P-30 class.

Only proven designs are considered. The reason for this is that the rigging angles are already established. However, you will use the same flight trimming techniques if you are adjusting an original design.

Basics: Before you leave the house be certain you take care of these basics:

Is the decalage correct? (decalage is the angular difference between the wing and the horizontal stabilizer)

Is the incidence angle (if specified) correct? Incidence is the angle that the wing chord makes with the longitudinal axis of the airplane. The longitudinal axis runs from nose to tail.

Are the down thrust and side thrust angles correct per specifications in the plan?

Except for specified twists are all flying surfaces free of warps?

Are the wing and horizontal tail surfaces set to the specified relationship with the longitudinal axis? The wing and stab usually are set at right angles to the longitudinal axis of the plane. Sometimes the wing may be offset to one side to assist turning.

Are keys applied to maintain this alignment?

Does it balance at the proper wing chord position that the plan shows?

Check the dethermalizer (DT) for smooth operation.

Do you have a snuffer tube, (the field is not the place to check this)?

Is the fin parallel to the longitudinal axis?

Does the nose block retaining device work positively and does the prop free wheel easily?

Is the prop hook, used by the rubber to drive the prop shaft, bent correctly on the shaft centerline (CL)? If this bend is off center, it will cause a power robbing vibration.

Do you have an extra motor made up and lubed in a "zip Lock" type bag?

Are you going to have a helper or will you need a stooge?

Flight Testing: With this behind you, you're ready to grab the flight box and head for the field. I won't go into the flight box goodies, just be sure you have the basics you need for this type of plane. And don't forget the dethermalizer fuse, a fuse lighter, thin balsa for shims, a model knife and some glue.

Don't be too hasty though, as you will want a calm set of atmospheric conditions to exist for testing. Early morning (before 10 a.m.) or late (a couple hours before sunset) usually exhibit the most stable air.

There are two separate flight conditions (power and glide) that must be trimmed. These must be independent if each condition is to be maximized. Therefore you will do one and then the other.

The test glide portion: If you haven't done this before, it will take some practice. You will need to develop a feel for each plane. Hold the plane at the balance. The object is to release the plane at the proper glide air speed and at the proper glide angle so you can observe the craft's true glide behavior. If you throw the model faster than the normal glide speed, it will exhibit a stall that is the fault of the launch and does not represent the actual trim condition.

Likewise dropping the model from your hand before attaining the glide speed will cause it to dive to pick up flying speed. You will have arrived at the correct release when at least three glide tests provide the same consistent results. Start adjusting when you have a positive idea of what needs to be corrected.

Pick a point 30 to 40 feet ahead of the launch point toward which you will release the plane. Also, if you know your launch height you can step off the glide angle. This information with the time from release to touchdown will give an idea of the sink rate.

What is the plane doing? Does it gently porpoise (mild stall condition) or does it strike the ground without first gently flaring, when in proximity to the ground (slight dive)? If there is some radical departure from a normal glide you haven't done all of your checking at home.

A Notebook: Here is where a notebook comes in handy. You will want to keep track of your adjustments and of course the first rule in adjusting is to make one trim adjustment at a time. If you try two or more it is difficult to know which adjustment did how much of what. To establish a reference for determining the flight surface needing adjustment, think of yourself as in the pilots seat, i.e., left hand side of the fuselage and facing forward.

Adjust for the gliding turn by using horizontal stabilizer tilt. You will want the glide to go right, since the P-30 has a freewheeling prop. To decrease the turn circle, raise the right (co-pilots side) STAB tip, remember you're the pilot. To increase the circle diameter lower the right tip.

When the turn tightens the nose drops and the tendency is toward the dive. If you had a slight stall condition, tightening the turn could have corrected it.

If you had already corrected a dive or stall, by sliding the wing forward or aft (or added weight if the wing is fixed) you will now see an increased descent rate.

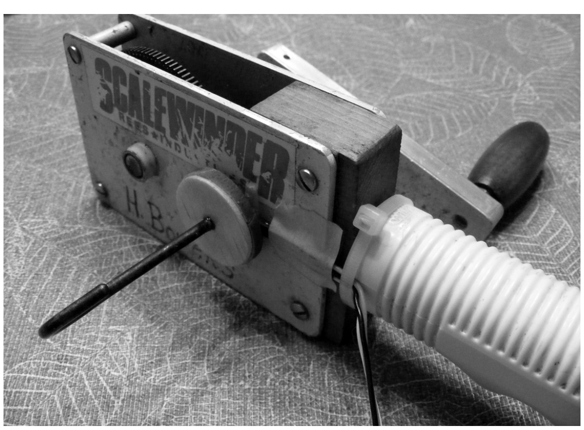
If you opened the turn up, the tendency would be toward a stall or slight pitch up. Caution: When a large shim is required for stab tilt, you may need a negative shim at the T.E. (trailing edge) to maintain your established decalage. Be patient and strive to set your glide circle near 70 feet in diameter.

The Power Portion: Now that you have the glide established (there may be some finer tuning later) you are ready to start with powered flight. Here again the notebook comes in handy to remember the number of turns etc. as you progress through this phase. Start with finger winds and check the propeller for proper tracking, before going to the winder. Using a motor blast tube is safe practice when the winds go beyond half power. It will take the brunt of a motor break, should this occur.

These beginning winds should be done with the motor stretched 3x its relaxed length. About 100 to 120 propeller turns is a good number to start the first flights. About 20 to 24 cranks on a five to one (5:1) winder.

The P-30 or any rubber powered model, comes under the heading of those having a stored energy power source.

The power is maximum at release of the propeller and declines continually throughout the power cycle. Just as you developed your launch technique for the glide, so will you do for the power launch. Try to launch at flight speed releasing the propeller first, allowing the prop to accelerate to avoid a left roll due to torque produced in overcoming the propellers inertia. During the power phase all warps will have an increased effect over that found in the glide, so you will start out well below maximum winds. Make certain you're using a lubed motor to reduce the sliding friction that leads to rapid abrasion of the rubber.



"Monkey Shit" Ballast

Stew Meyers

The modeling clay commonly used for ballast by modelers is oil-based. Oil-based clays are referred to by a number of genericized trademarks. They have been around for quite a while. Plastilin, was patented in Germany by Franz Kolb in 1880. Plasteline was developed by Claude Chavant in 1892. Plasticine was invented in 1897 by William Harbutt of Bathampton, England. Plastilina is trademarked as Roma Plastilina by Sculpture House, Inc. And Crayola® Modeling Clay is widely available today.

Oil-based clays are made from various combinations of oils, waxes, and clay minerals. Although the exact composition is a secret, Plasticine is composed of calcium salts (principally calcium carbonate), petroleum jelly, and long-chain aliphatic acids (principally stearic acid). Because the oils do not evaporate as does water, oil-based clays remain malleable even when left for long periods in dry environments. Articles made from oil-based clays cannot be fired, and therefore are not ceramics. Oil-based clay melts when exposed to heat, and is flammable at much higher temperatures. Because the viscosity of oils decreases as temperature rises, the malleability is influenced by heating or cooling the clay.

There are some problems with oil-based clay however. It smears on a hot day and wont adhere very well on cold days. It's greasy and the oil may seep out into the paper and balsa it's adhered to. The dyes commonly present also can stain structure. Eventually it can harden a bit due to migration or out gassing of the oils.

There is an modern alternative, Duct Seal Compound, aka "Monkey Shit". This compound seals conduit openings against drafts, dust moisture and noise. It also protects terminal boxes, pot heads and bushings from corrosive elements and deadens switch gear panel noise. The dough-like compound is easily "thumbed" over holes and gaps. It will not harden or form a skin under normal conditions. It has much better temperature properties than clay. It adheres at -20 ˚F (-29 ˚C) and will not slump after 1 hr. at 350 ˚F (175 ˚C). It is at least as dense as modeling clay. I recall we used it to seal vacuum chamber leaks at NASA. It has much lower out gassing properties than oil-based clays and does not get greasy on hot days. It comes in one pound bricks for under $5. Your local hardware store will probably have it and know it as "Monkey Shit". If not ask for Gardner Bender Duct Seal Compound - DS-130. Try it, you'll like it.

This is not "Plumbers Putty" which goes hard all too soon.

The photo opposite shows a Rees winder with a hall-effect sensor on the output shaft. There is a magnet embedded in that balsa disk to excite it once per rev.

Richard Morgan's
Small Rubber Cabin Model
(Circa 1939/1940)

Born in June, 1921, Richard Morgan was an accomplished member of the prominent Windsor (Ontario) Model Airplane Club. He won the 1939 Canadian Wakefield Championship with a design later kitted in modified form by Easybuilt of Toronto. After placing highly in the Canadian National Wakefield competitions of 1940 and 1941, he followed his trade of pattern making into the United States in 1942, taking up sport aviation as a hobby. Enlisting in the United States Army, he eventually qualified as an infantryman and was decorated for bravery during various island fighting of the Pacific campaign. In early May, 1945 he was killed in action on Okinawa. His remains were returned to Windsor, Ontario where the local media fittingly eulogized him as "...enthusiastic builder of model airplanes..."

Intending to kit a small rubber model as an offering Morgan Model Supplies, a hobby business he ran from his home, Richard designed this 25 ¾" model at some point before graduating from high school in mid 1940. Discovered among his aeromodelling effects, it is the only original plan of designs known to have surfaced. Both the incompleteness and pristine condition of the original drawing testify to the accuracy of the recollection of a close modeling friend that a prototype was never built. This plan, carefully traced from the original, is modified only by the addition of ribs, nose formers and the drawing of both halves of the wing and stabilizer. A handwritten bill of materials on the original plan indicated the structural dimensions not obvious on the plan itself.

The leading edge of the wing is 1/8" x ¼", the latter set vertically, and the trailing edge is 3/8" x 3/32". The builder may wish to fully extend the leading edge beyond the tip rib, trimming the wing tip accordingly to fit the rear of the leading edge. The spar is 1/8" square and would have been tapered appropriately at the tips. The airfoil of the 1/16" ribs is not shown on the original, but Richard exclusively employed Clark Y sections until 1941. Both main and tip ribs were derived from the actual pattern he used before switching to the Eiffel 400 section. As per the drawing, Richard did not inlet ribs. The tips of the wing, stabilizer and fin are from 3/32" sheet. The wings dihedral is not shown, but 1¾" to 2" could be considered.

Apart from the 3/32" tips, both fin and stabilizer are of 3/32" square. On the original drawing, the stabilizer was indicated exactly as per the top view which shows only the right half. Thus, the full stabilizer drawing, included on this rendition, deliberately does not indicate the centre section's intended construction as it is unknown. A few gussets might be warranted.

The fuselage is a traditional box of 3/32" square. The positions, but not the actual shape, of the elliptical 3/32" nose formers were not shown on the original. Richard is known to have covered nose formers with 1/32" sheet in at least early 1940. The meaning of the diagonal stick on the windscreen area of the side view is uncertain. The rubber hook/tail skid was anchored in a sandwich of sheet. The landing gear, probably of .047" or less, has no details of attachment to the fuselage and may be a bit short with an appropriately sized freewheeling prop.

The intended prop was not indicated but an 8" to 8 1/2" prop would be SAM legal. Six strands of 1/8" tan rubber are suggested as a starting point to power the model.

(This text I from the June 2004 SAM 35 Speaks)

My Richard Morgan
Small Rubber Cabin

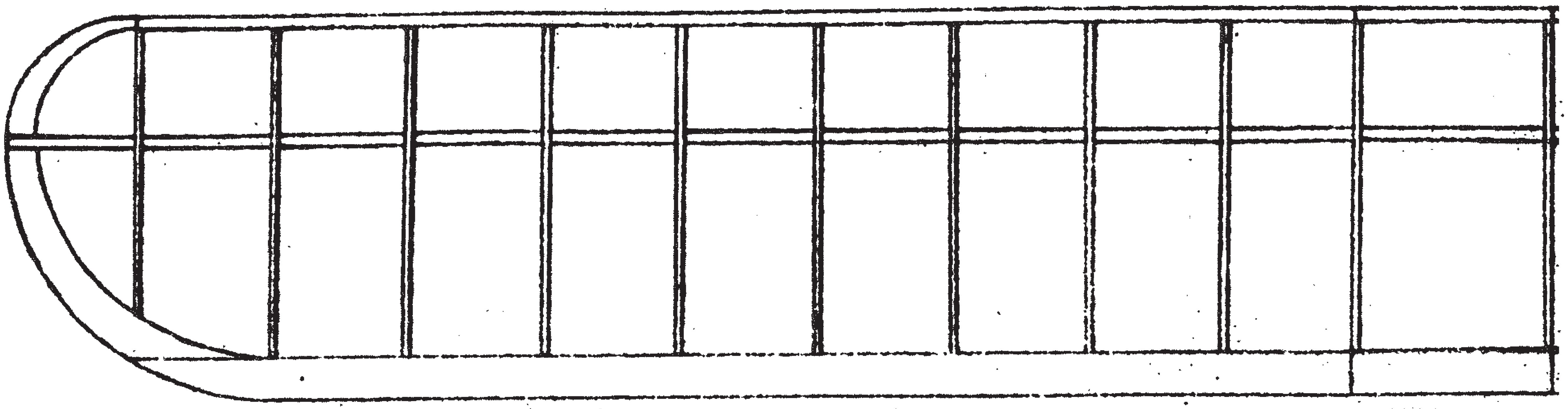
Dan Driscoll

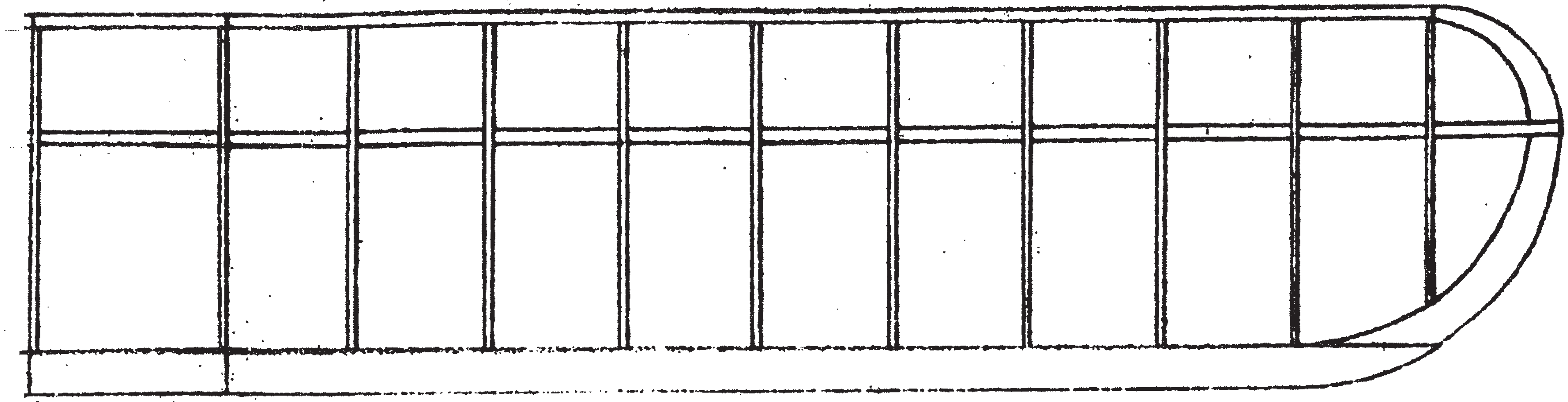
I saw this plan in the June 2004 SAM 35 Speaks and liked the story behind it.

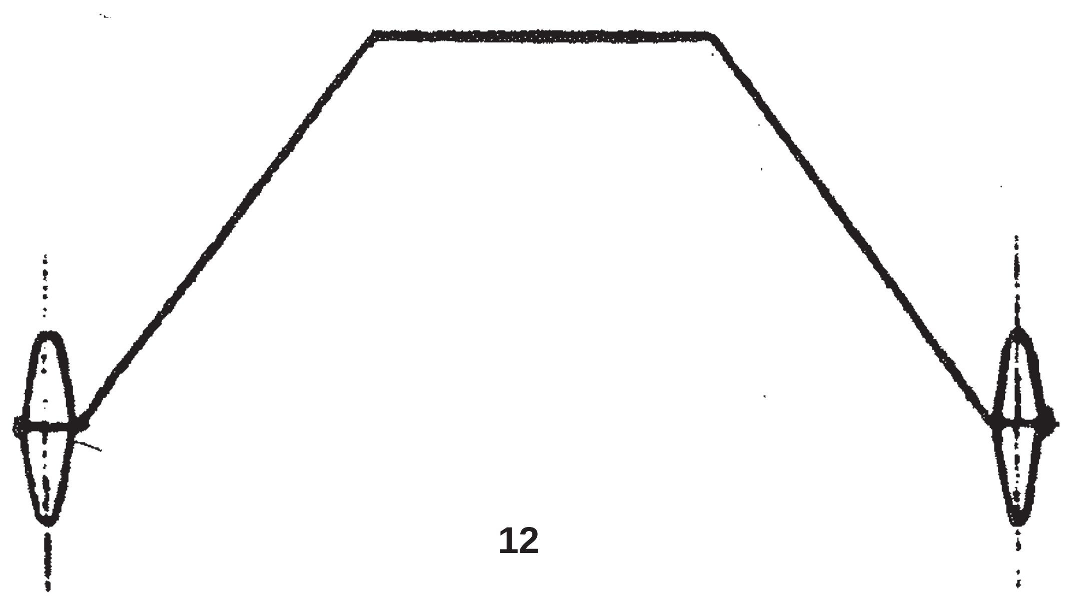
I built my model pretty much per plan with the following changes: moved rear motor peg forward one bay, sheeted the nose sides and bottom, incorporated removable wing and tail, and used a button DT. The model weighed 40 grams w/o rubber and I have since added three grams of nose weight. Prop is 8 1/8" diameter blue plastic that I got from Easybuilt several years ago. (It is no longer in their catalog.) The CG is at the wing spar and considerable down thrust was needed. I use 128" of 3/16" rubber (17 grams) in four strands tightly braided and 1300 turns. Model flies in a left/right pattern with a very steep climb.

How does it fly? After some hectic trimming on the day of the event, it surprisingly won Old Time Rubber 2 bit + 1 at the 2014 FAC Nats.

Dan’s Richard Morgan Small Rubber Cabin.



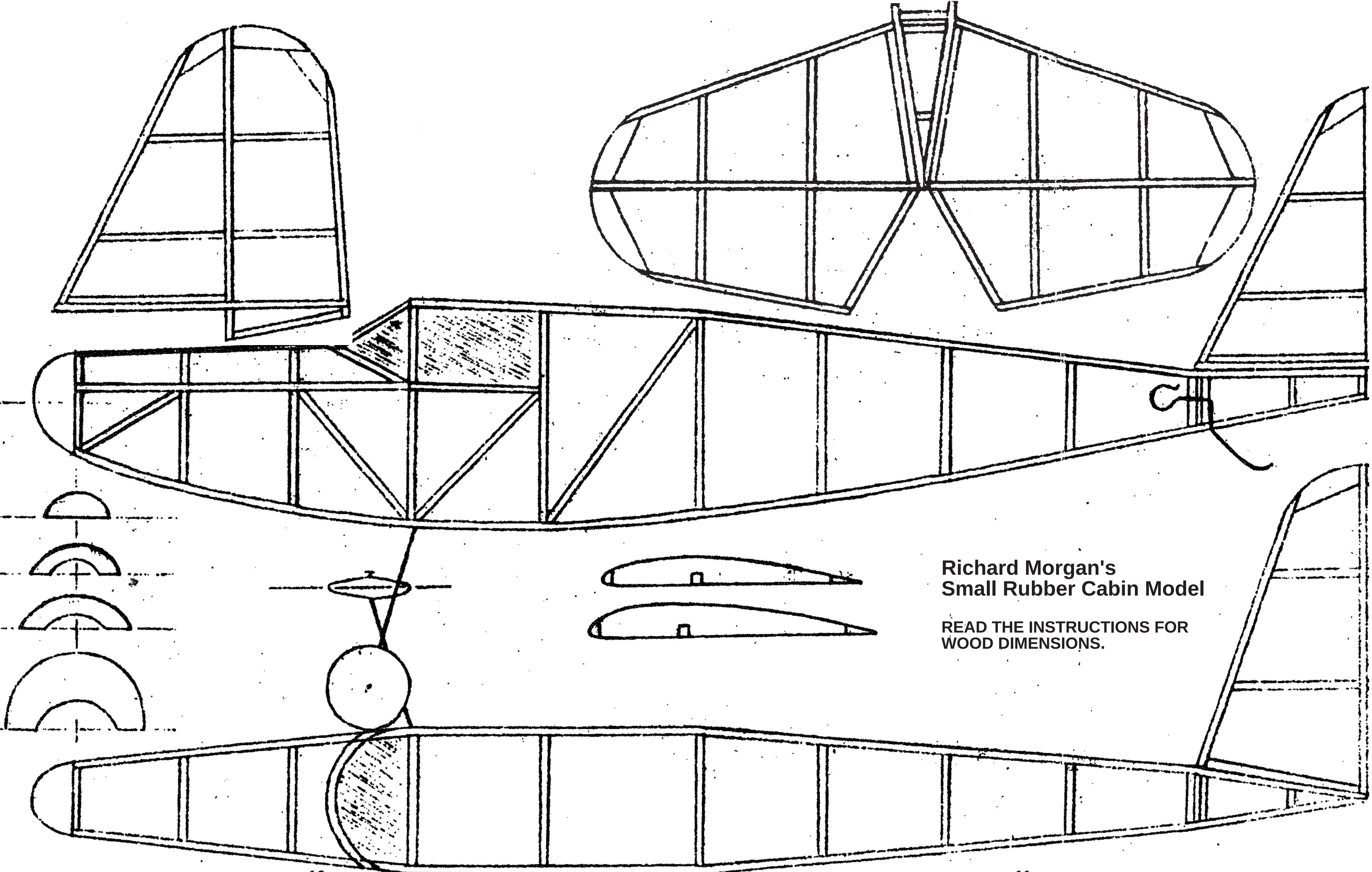




Richard Morgan's Small Rubber Cabin Model

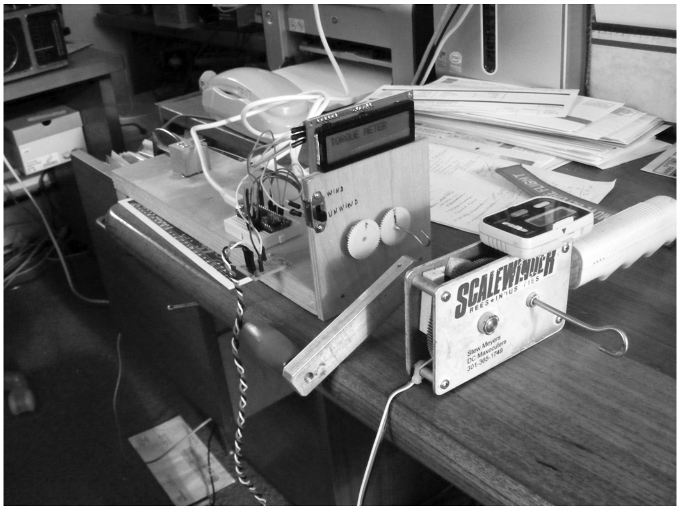
READ THE INSTRUCTIONS FOR WOOD DIMENSIONS.

NOTE THE CENTER SECTION IS SHOWN ON BOTH WING SIDES.


Richard Morgan's
Small Rubber Cabin Model
READ THE INSTRUCTIONS FOR
WOOD DIMENSIONS.

Recording Torque Meter Development

Stew Meyers



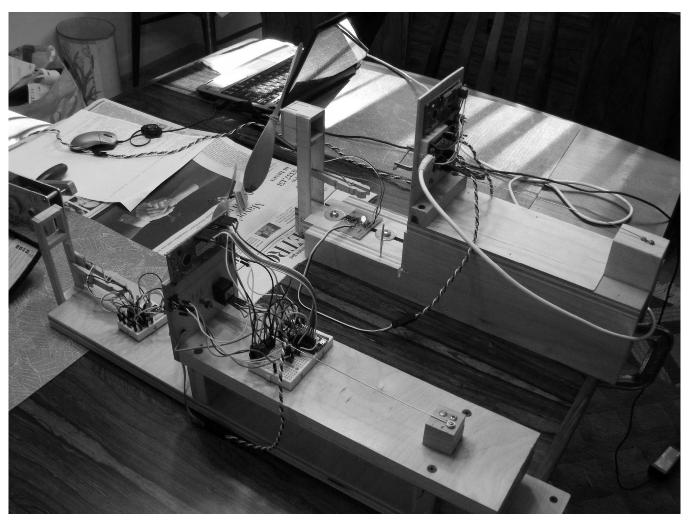
Here is the original prototype clamped to my desk and plugged in to my computer. The Rees winder already had a magnet on the input gear to drive a reed switch connected to the pedometer counter. A hall-effect sensor was added to detect the magnet's passing when the gear rotates. This provided a count every ten turns; rather sparse to my way of thinking. I put the hall-effect sensor on the output shaft. I then used a disk with four magnets that gave a count every quarter turn. That was too much information, so I ended up with a disk with one magnet to provide a count once per rev. That was the Goldielock's solution.

You might notice from the photo that the winder crank arm is longer than the distance the torque meter hook is off the table. I missed that when I built the rig, probably because my initial tests had been done with a K&P winder and no counter. This results in an off axis wind that distorts the torque reading. The moment put on the bearings creates torsional friction. These testers use 9.5 inches of 0.032 music wire as the torque wire. This results in a deflection of 30 degrees per inch ounce with a 12 in-oz max torque. The encoder has a resolution of 1024 bits per revolution. That's 12/1024 or 0.012 in-oz resolution. Yes, you can see the effect of an off axis wind.

I decided to put the unit on stilts and while I was at it to add a nose block holder to mount a prop as I intended to record the prop run down rather than just using the winder to unwind the motor. To this end I added a winder/prop switch to the panel to redirect the source of the input pulse. I already had the wind/unwind switch on the panel which directs the turns be subtracted from the total during unwind. The prototype forced one to reach behind the panel to press a button on the Arduino Microprocessor to reset it. Rather awkward when running a test, so I added a reset button to the panel.

This became the MK-1 Recording Torque Meter(RTM). It worked pretty well with the winder and allowed me to work the bugs out of the programs on the Arduino, PC and Excel spreadsheet. I then added an Infra Red Photo diode to detect the prop passes. I had some problems with this. It appeared flakey and inconsistent. I was getting erroneous counts. I conditioned the pulse with a Schmitt trigger, that improved matters, but I still was missing prop passes at high rpms. I changed the pulse input to use an interrupt rather than a digital input. The problem persisted. It seemed the time to read the shaft encoder and output the data to the display and PC took too long and the next pulse or two was missed while this was going on. I changed the LCD display from serial input to direct input. That did not help much. Then it dawned on me I was receiving two pulses per revolution of the prop blade which I was counting and dividing by two in software on the Arduino. I could double my speed by doing the division in hardware before the pulse reached the interrupt port. I added a D-FlipFlop chip to the IR pulse conditioner. This chip had two circuits on it that could be configured to divide by two. I put them in series to divide by four. Now I get a pulse every other revolution of a two bladed prop. This effectively increased my computing speed by four. I then reprogrammed the Arduino to count by two when the input is coming from the prop. Taking readings every other rev is still plenty fast enough to see all kinds of funny stuff going on when the prop unwinds the motor. This MK-I unit uses a solderless breadboard for easy prototyping and the wiring is a mess.

The MK-II unit uses a copper breadboard with soldered connections for more reliability and a cleaner setup. It also uses a different Arduino chip and has better gears. Dave Mitchell made up a new frame that has provisions to vary the hook length of the motor. The rear hook has been replaced with a cross tube capable of holding a "wobble peg" to more faithfully emulate the actual installation of the motor in the model.

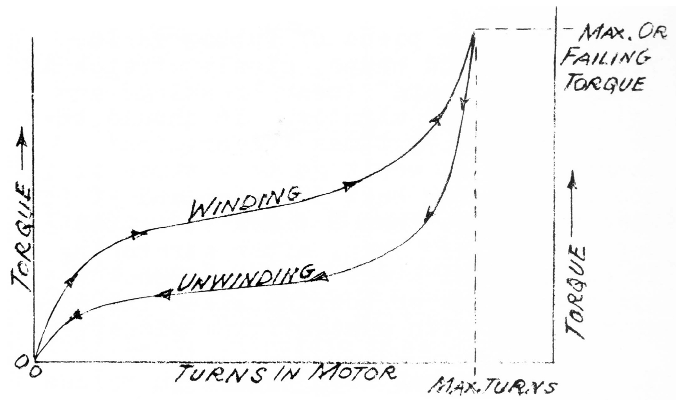


This view of the MK-I (in front) & MK-II RTMs best illustrates the wiring cleanup. Both units are fully functional and produce similar results.

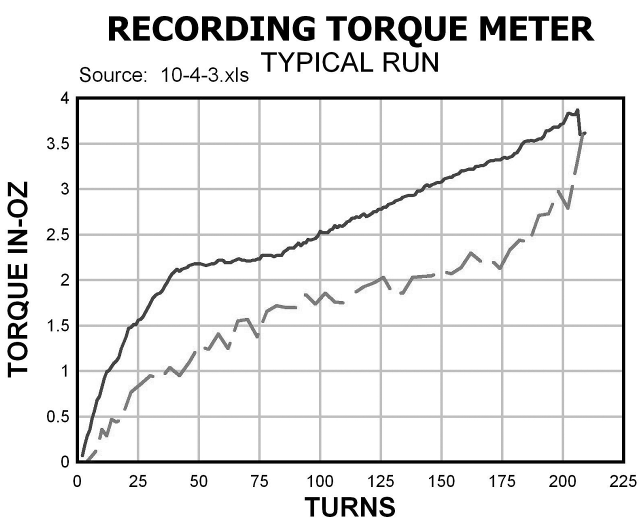
RTM Obseravtions

Stew Meyers

Using the RTM was a real eye opener emphasizing the interplay of torque and tension. The ideal “S” shaped hysteresis loop of the typical rubber motor being wound and unwound like that shown below from McCombs is hard to reproduce in the real world.

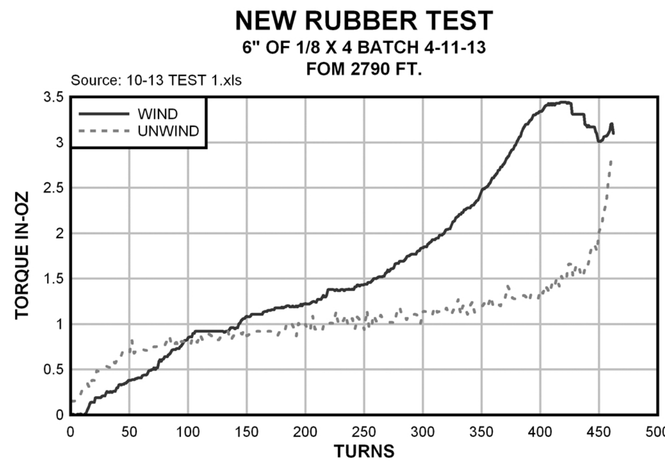


The influence of tension on torque is profound and tension must be kept near constant to approximate this curve. What we actually see looks like this.

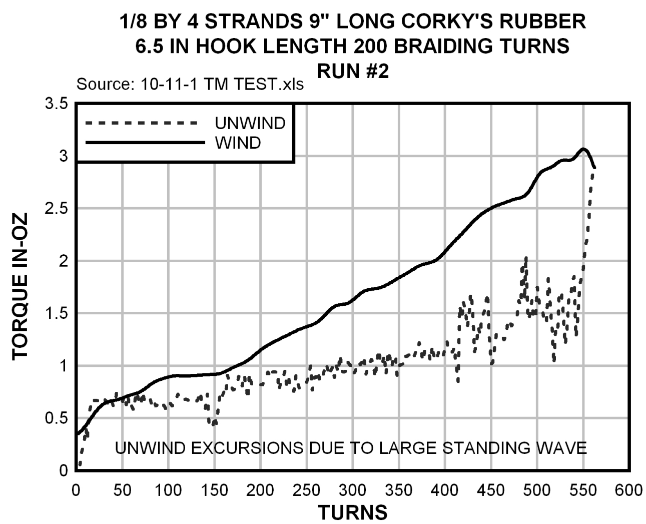


This particular run was not wound close enough to max to see the increasing slope at the upper end of the wind curve. You can see the drop as tension was relaxed to insert the nose block into the test rig. The bumps in the lower unwind curve are due to knots unwinding.

The next plot duffers from the classical Torque Turns curve as below 100 turns the unwind curve is higher than the wind curve. At first glance this seems to be impossible. This is entirely due to tension during the winding process. In addition to the torque excursions at the high end when inserting the nose block, the motor was not tensioned enough at the start. It took a few winds to register any torque at all and the curve is therefor shifted somewhat to the right. The unwind curve on the other hand is tensioned by having a fixed hook length. You can’t always look at a given number of turns and assume the unwinding torque will be less then the winding torque at that point. The rate at which the energy was put into the rubber motor is independent of the rate at which it is removed.



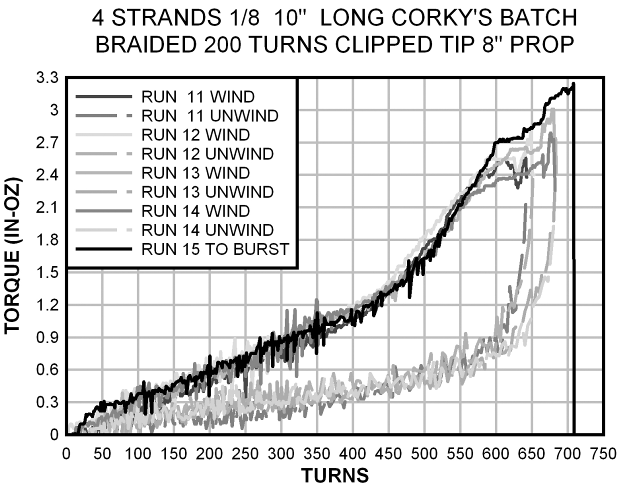
Below we see the effect of a rather large standing wave and the typical large drop in torque in the initial power burst



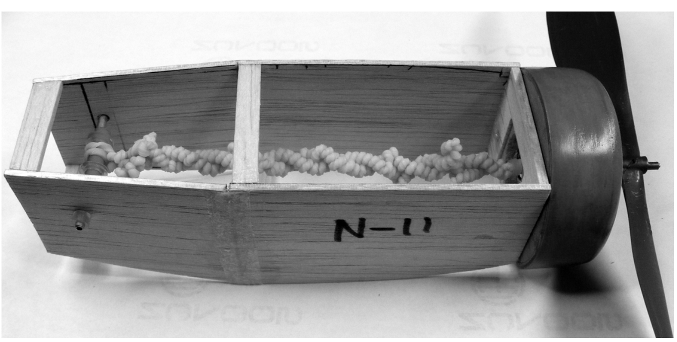
Looking at these plots illustrated for me why the indoor guys let out some turns before they fly. They want to get rid of the initial power burst and operate on cruise power. In these plots there is not a lot of energy lost in those first unwinding turns, and the torque only varies form 1.5 to 1 in-oz over the cruise range.

If your FAC ship is squarely at full winds maybe letting the prop go at the start of a mass launch count down might be a good idea.

. Superposition of several runs of a well used motor shows consistency except in the last few winds as the motor is walked in. I need to work on my winding technique



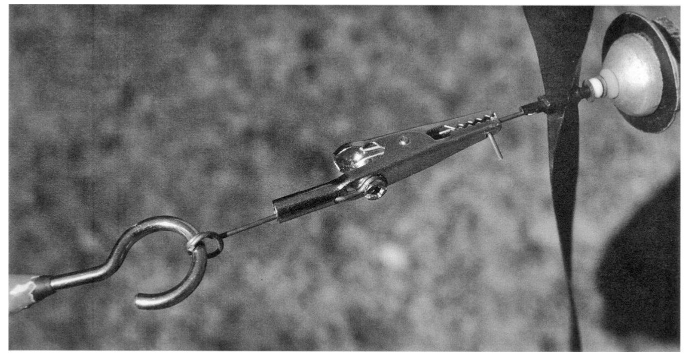
Let's examine some Torque -Turn plots and see what we can glean from them. It becomes obvious you want to minimize the torque drop that occurs when you reduce tension in the motor while hooking up the motor to the prop shaft. Fumbling around and releasing winds to open the rubber loop isn't the way to go. An "O" ring, Crocket hook, or wire clip really pays off here. However you need to be careful not to induce standing waves with these. If the clip or ring climbs the "S" hook, it can move off center which will aid in setting up standing waves. This also will suck energy out of the system due to bearing friction from bending moments on the prop shaft.



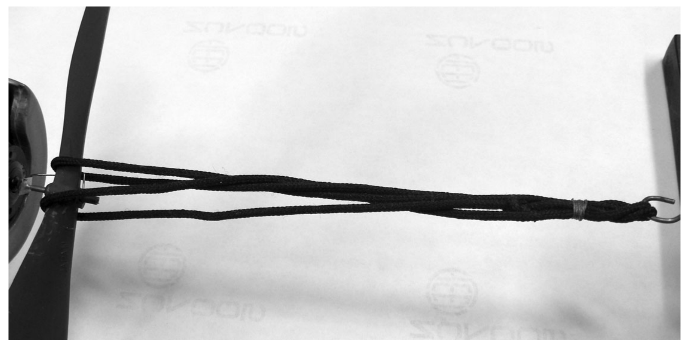
This dummy fuselage aids in testing for binding, hook climbing, and standing waves

You needed to stretch the motor to near full tension, 5-7 times the unstretched length when starting to wind to get the rubber to knot up smoothly. You then walk in while winding trying to keep a constant tension. In the past, I have used a wire torque meter and watched for a rapid rise to indicate approaching max torque. What I missed was the drop in torque that occurs when you remove the rubber from the winding hook or torque meter and attach it to the prop shaft. You want to wind the motor in maintaining tension as you move in as close as you can to the nose of the model.

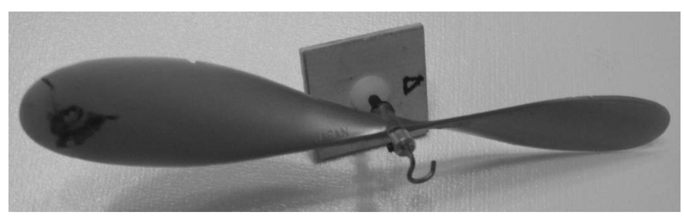
Use a wire through the Crocket hook or ring when removing the winder and hooking it to the prop shaft.



For small motors with a ramp type clutch like that on a Peck Prop and a ninety degree bend on the prop shaft, you can use an alligator adapter like the one I developed in the '70's.



Bruce Foster came up with a simple loop to couple the prop to a winding hook. However you need to be careful if you use a swing bail clutch with a piece of insulation to hold the prop on the shaft. If the bail comes loose the prop can slip off and the nose block will slam into the front of the model.



To minimize this tension-torque drop for testing, I use a special nose block with a winding hook on the front end of the prop shaft. I still get somewhat wonky plots as I try to maintain constant tension while inserting the nose block.

I plan to make a nose plug adapter for the RTM which will hold the actual model nose blocks. This will allow me to use the actual "S" hook for the proposed motor. I can adjust RTM MK2 to the same hook length as the model. I can then accurately test the effects of different rubber lengths and braiding on the performance of the motor. The actual "S" hook makes a real difference as does the "wobble tube " at the rear end.
I also wonder about the effects of thrust alignment adjustment. Well that begs another series of tests.

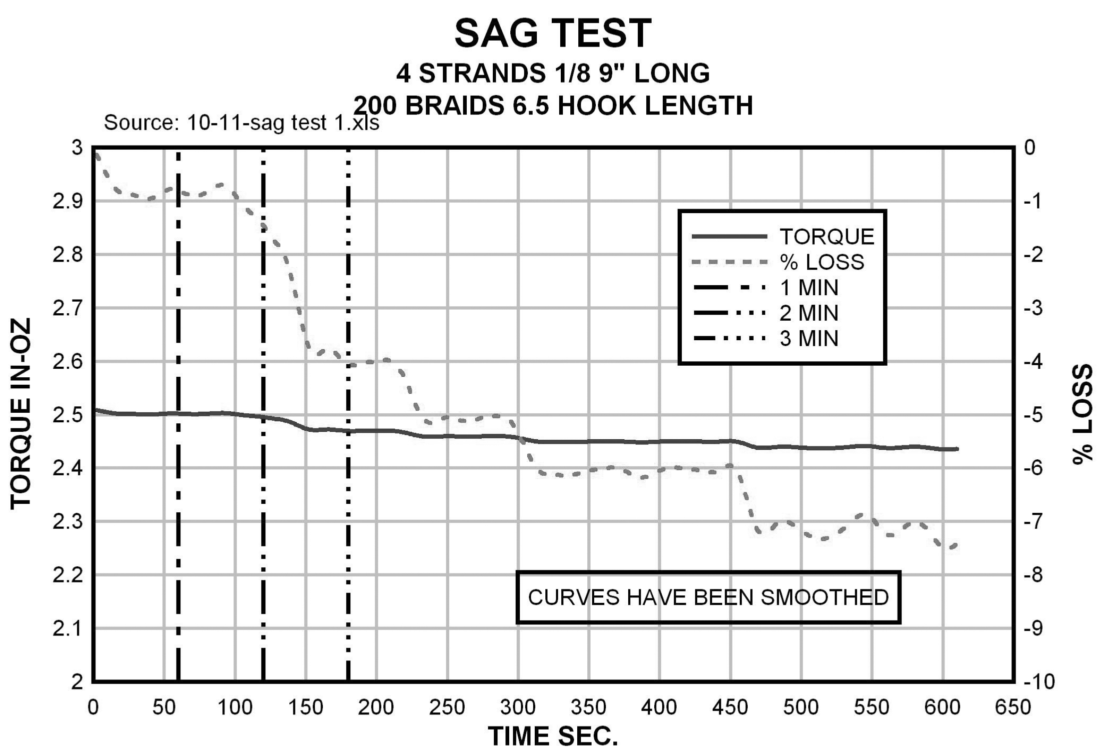
Sandbagging & Sag Testing

Stew Meyers

During the mass launches at the Outdoor Champs at Muncie last month, I noticed a ‘race’ to be the last one wound. Now it’s common lore that a wound motor loses torque over time. The impetus here is to get an advantage by being the last one wound and therefore have the least loss of potential energy or “SAG”.

This set me to wondering just how much energy is lost over time? Of course you shouldn’t need a fancy-dan recording torque meter to run this test. A simple wire torque meter will do the job since the purported phenomena takes place slowly. Simply put a couple of hooks on a board placed far enough apart to match the torque meter length plus the hook length of your favorite mass launch model. Attach the torque meter to one of the hooks and attach your motor to it. Wind up your motor as you usually would and instead of removing it from the torque meter, place it on the second hook. Now observe the torque meter. Write down the value of the torque every 15 seconds. A timepiece with a sweep second dial works best here. (In full scale flying as well, analog beats digital for several instrument displays.) You will find the torque diminishes very slowly, being barely discernable in the first few minutes. In fact with this simple rig you can’t really put a good value on it. Over longer time periods the drop is more evident.

OK, let’s see what we get from the RTM*. It was a trivial matter to reprogram the Arduino on one of my recording torque meters to ignore the winder and simply output the torque every second. A mere 600 data points covers 10 minutes. More than enough time to establish what is going on.



Not surprisingly, the sag loss is dependant on the percent of max torque the motor is wound to. At 50% there was no appreciable drop over ten minutes. For the particular 1/8" rubber I was using at 60% (not unreasonable for the first sortie in a mass launch event), the loss was less than 1% for the first minute, 1.5% at two minutes, and 4% at three. After ten minutes the drop was 7.5%. These are smoothed curves. The “bumps” are due to changes in torque when a knot is relaxed and the winds redistribute.

The RTM with the SAG program allows us to get real numbers, but raises the question is the percent drop in peak torque indicative of the total energy loss? The area under the energy curve is the question. Is the curve shifting or is it only the start point? The torque drop is very steep for the first few unwinds.

Gong back to the basic RTM program and waiting a period of time before going to the unwind phase might give us a better handle on how much actual energy is lost. Well maybe, however after doing several runs, I found the loss of torque when reducing tension while transferring the rubber from the winder to the prop hook and inserting the nose block far exceeded any loss over the first ten minutes of sag time. To minimize this initial torque loss, I have a special nose block prop combination that has a winding hook built into the front of the prop shaft. The results however, are still inconclusive.

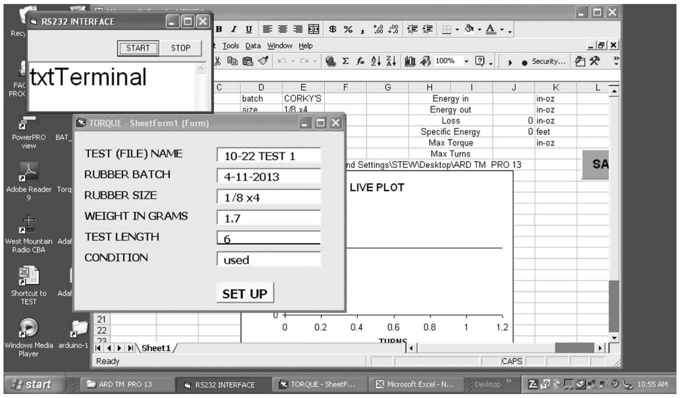
That being, said let’s assume the worst. The total energy available is a function of initial unwind torque. Now for a fair Mass Launch, no one should be forced to hold his winds more than a minute or so longer than his competitors. To accomplish this, don’t give the start winding command until every one is ready, and give a firm limit to the wind time allowed. Say 3 minutes. At the end of this time, you must stop winding with however many winds have been applied. This would apply to those winding at their stooges as well.

By the time we are ready to launch, every motor will have a some what diminished initial torque, but there won’t be a perceived advantage to those that were the last to wind while others waited around. And of course, those who wind closest to max will have the most loss, however small it may be.

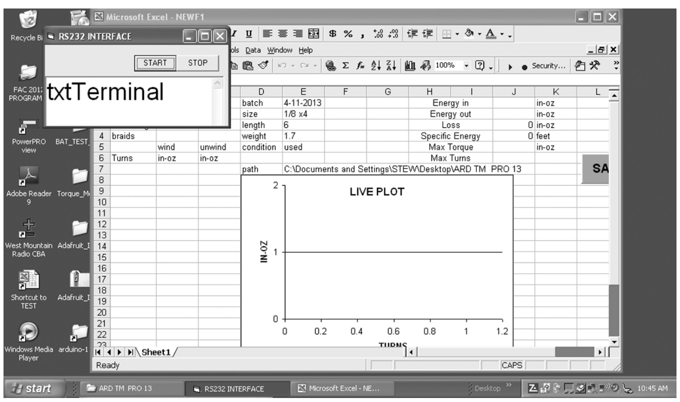
*RTM, a device I created to measure and graph input and output torque.

RTM Screen Shots

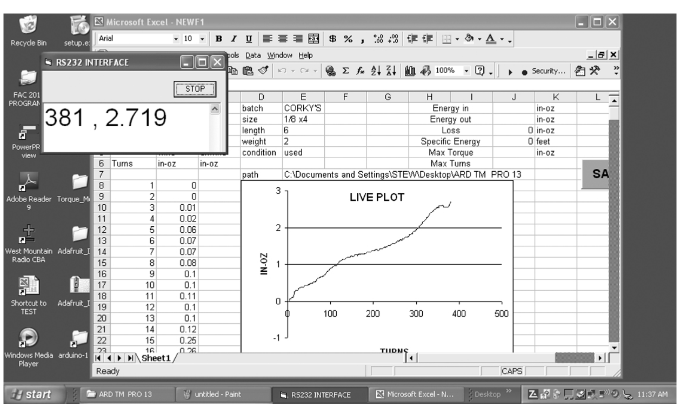
When the program is run on the laptop this terminal form appears. When the NEWFILE button is clicked the program brings up a copy of an Excel spreadsheet and a form to modify it for the particular motor under test.



Fill this in and click set up to transfer the data to the spreadsheet. This brings up the next form.

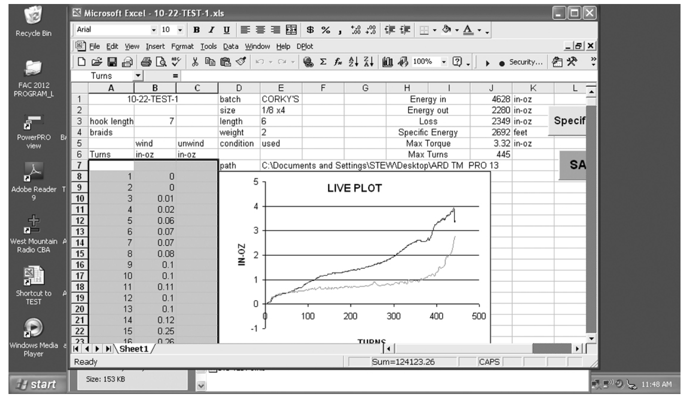


Now if the START button is clicked, data can be received



and plotted. Note data appears in the terminal window as well as plot.

When the motor is fully wound and the nose block seated, the switches are thrown and the prop released for the unwind phase.

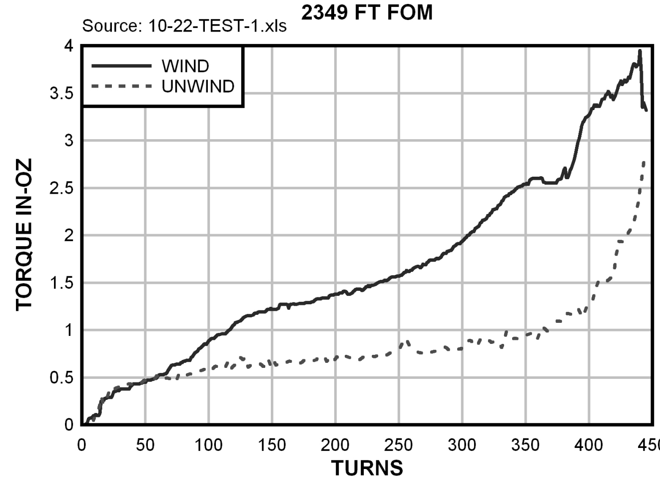


When the test is over. Click the STOP button on the terminal form, the program exits and the form goes away. The Specific Energy button appears on the spread sheet. When this is clicked the FOM and energies are calculated from the values on the spreadsheet. The data area of the sheet is also highlighted and named. This is to make it easier to run “Dplot” to make more sophisticated plots like the one below.

TYPICAL RUBBER MOTOR TEST

6" OF 1/8 X 4 2 OZ

2349 FT FOM



Dplot from http://www.dplot.com makes it easy to graph and manipulate data. Curves can be superimposed from several different runs.

The values from the spreadsheet are:

Energy in	4628	in-oz
Energy out	2280	in-oz
Loss	2349	in-oz
Specific Energy	2692	feet
Max Torque	3.32	in-oz
Max Turns	445	

You can see the torque varying as I wound it up with uneven tension and the drop inserting the nose block into the test rig.

RTM MK2

Stew Meyers

The Recording Torque Meter Mark 2 (RTM mk2) system consists of the test rig housing an Arduino micro controller and Bourns EMS22A Non-Contacting Absolute Shaft Encoder geared one to one to measure the angle of twist of a rugged wire torque meter. The Arduino also detects pulses from a winder. A hall-effect sensor on a Rees winder detects the passing of a magnet on the output shaft. This is in turn routed to a digital interrupt pin on the Arduino micro computer via Futaba servo extension cables. This pulse registers a turn and reads the position of the shaft encoder which is translated into in-oz of torque. If the wind switch is in the wind position the turns are added to the total. If the switch is in the unwind position the turns are subtracted from the total. There is another switch that changes the pulse input from the winder to an IR detector that senses prop blade passes. A Schmitt trigger and 'D' Flip-Flop is used to condition the pulse and divide the pulse count by four. Thus for a two bladed prop, the torque is recorded after four passes or two revolutions of the prop and the count is incremented by 2 rather than 1.

Turns and Torque are displayed on the LCD display and sent to the computer over a USB port as CSV (Comma Separated Variable) data. A program on the P/C displays this data in a terminal form, stashes it on an Excel spreadsheet, differentiating between winds and unwinds, and displays a real time Torque-Turns graph. If the motor blows you have the values recorded and the system is strong enough that no damage is done to the rig.

The Excel spreadsheet has embed micros to further process the data to compute energy in and out and the FOM for the motor. Of course you then can take the data and work it over with a better plot program like D-Plot.

Future developments will be capturing time for unwinds leading to rpm and power for props and hopefully a way to record tension as well as torque.

TESTING QUIRKS

When attempting to make test runs, I found there were several possible pitfalls. Things have to be done in the proper sequence. The switches have to be in the right position when data is transmitted to the P/C and the Arduino must be reset to clear the count and set zero torque before the start button is clicked on the P/C to start receiving data and the winder crank is turned to initiate the process of sending data. For the prop unwind phase, in addition to putting the wind/unwind switch in the unwind position, the winder/prop switch must be in the prop position with no direct incandescent light flooding the IR detector.

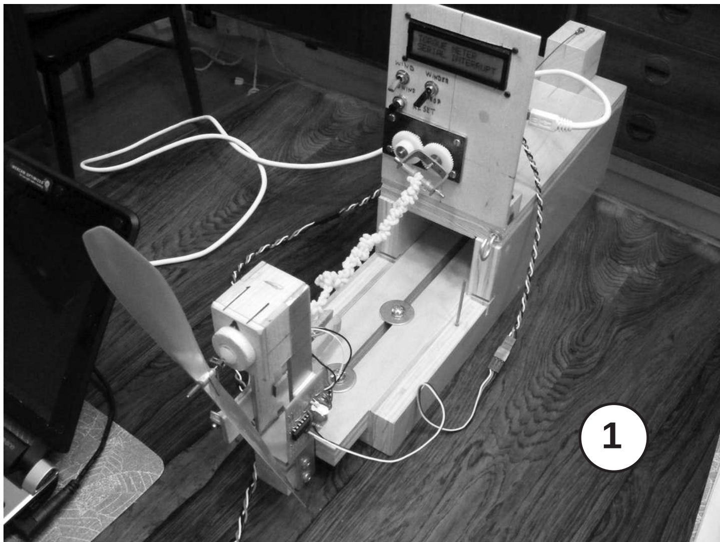
TENSION MEASUREMENT

Stew Meyers

To investigate the relationship of torque to tension, I got a #84707 Digital Pull Meter from Micro Mark. Unfortunately this meter does not read continuously, but goes into a hold mode if it thinks the pull has stabilized. So it essentially reads the max pull. It also turns off after 90 seconds. If you hit the off-on button before the 90 seconds is up, you can get out of the hold mode and get new readings. A little awkward while winding, you need a third hand. That being said, I did determine that 4 strands of 1/8 goes hard at about 40 ounces of tension. It is also obvious that the Torque-Tension relationship is not a linear. This tool would be better used to check out tension vs. extension for different batches of rubber. However, I would be leery of using this meter to pull rubber to burst because shock might damage it. Perhaps comparing the batches at an extension ratio of five would be conservative enough.

PHOTOS ON P-19

1. Over all view of the RTM MK2. The two screws with the big washers in the slot can be loosened to slide out the nose block mount to vary the hook length from 6 to 15 inches. The IR pulse signal conditioner is mounted on the side with a Futaba servo extension going back to the Arduino.
2. The other side of the RTM MK2. The IR detector and IR LED pair are set to have the prop reflect light from the LED to the detector. The clothes pin is used to position these for different props and nose blocks. The servo extension on this side goes to the winder.
3. Face of the winder showing switches and LCD read out. The front of the twist wire torque meter has a "U" mount holding a cross tube rear rubber mount with a "wobble" tube as well as a spur gear. The other matching spur gear is on the shaft encoder.
4. Rear view. Most of the wires go to the Arduino. the shaft encoder is the small black rectangle.
5. Close up of the IR detector and LED.
6. View of the entire set up with P/C LapTop running the program to record the data. The USB port powers the unit.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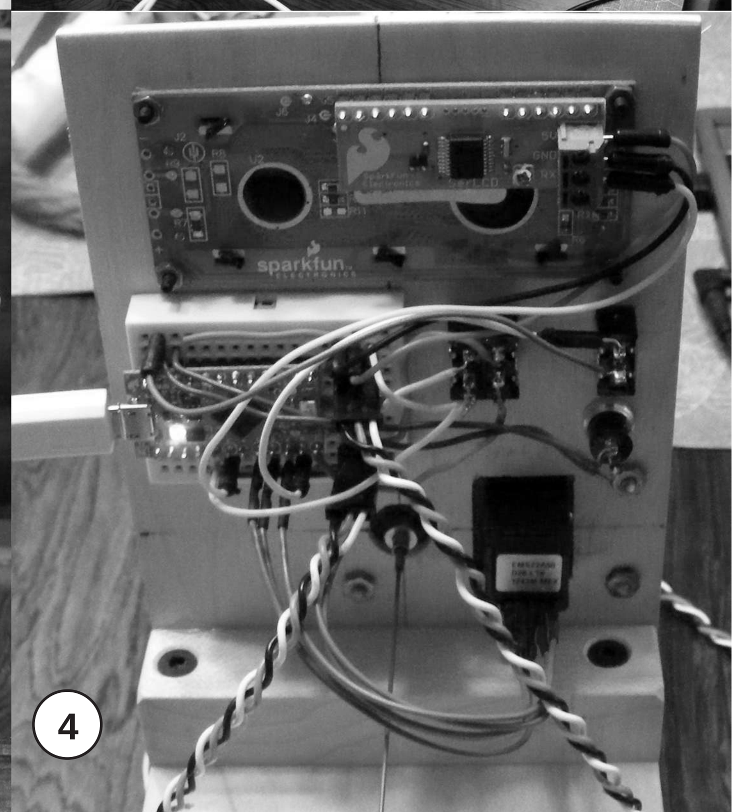
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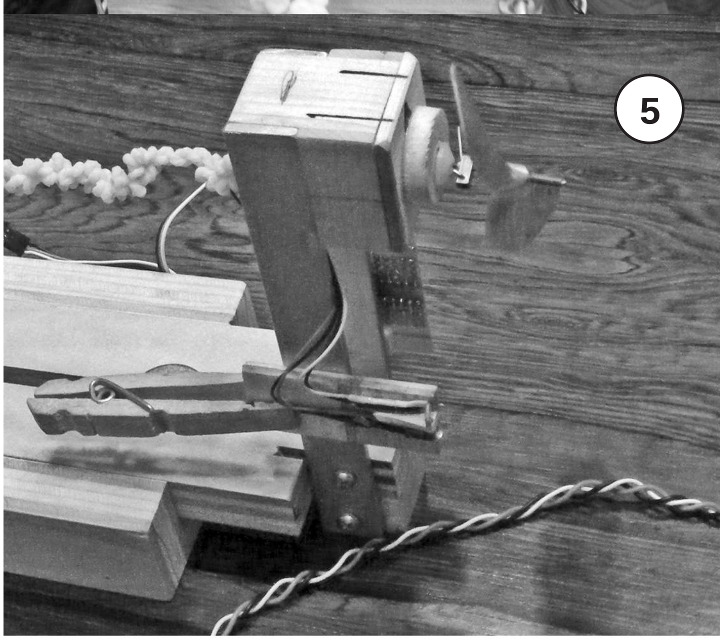
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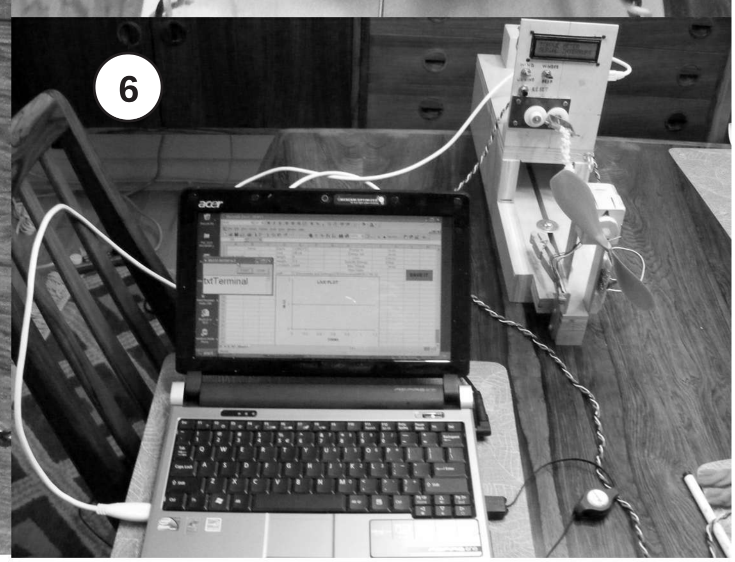
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RUBBER POWER ISSUE

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The way a rubber motor "Sags" or loses tension and therfore torque when it is held is highly dependant on how highly it is stressed, or the percent of maximum turns it is wound to. You can see jumps in torque as knots unwind. This "CORKY'S batch I am using for these tests is from an old batch of maybe Tan 2. It has less energy potential than current batches which probably will exhibit higher losses.