TECHNO-FILES

Make a CHAD FAI Model

(or: make a paper tiger fai model,
or: make a cheap and dirty fai model?)

Last issue we showed you how to make a CHAD FAI mandrel for around $5.00. (Not to be confused with some other "Chads" milling about...) The only problem with it was you really couldn't lay up a fiberglass model on it with wet epoxy. But here's the sneaky secret I didn't include: its for paper and vellum models which can out-perform fiberglass ones!

Yup, CHAD Ring
Has nothing to do with this article

Just look at the results of the recent US Team Selection Trials in Muncie. In S1 Altitude, Steve and Emma Krystal both beat me, flying my design. Practically identical models: I flew models made of fiberglass, they flew models made of VELLUM paper. They both beat me by nearly 80 meters. In an event that maxes a model's performance at about 350m – that's a huge margin! With PAPER!

Steve&Emma Krystal win big using paper models
Photo: Ole Ed Pearson

So, here is how you use your **CH**eap **A**nd **D**irty FAI mandrel to make ***Competitive, yes competitive,*** FAI models. Just ask Steve and Emma.

I hope you all realize that FAI models can be used in US competitions and can perform far superior to models made with heavy body tubes. Those may last a long, long time, but they don't win much against FAI models.

Now, have you seen the new NRC list of selected events for 2019-20??? ALL 1/2A Impulse!!!! These events just screeeeam FAI models due to their lower impulse – try it!!!!

There are many types of models made of paper. Perhaps you have built a desktop paper model in the past. Commonly made of index card stock or photo paper, they are usually rugged, hold a crease and hold their shape well, well, until the cat knocks it on the floor under the desk and you step on it. However these models made of card stock are much too heavy for our purpose. We eliminate the weight by using the lightest uniformly flat surfaced paper we can find (or even Kapton plastic which resists burning, somewhat...). Strength to hold up to the force of a launch comes from forming it into a tube. One way to prove this is to stand your paper tube vertically, place an index card on top and start adding weight. You will be surprised how much weight the tube will support, even with one single wrap. Cylinders are one of the most structurally sound, and strongest, geometrical shapes. Cylinders are able to be incredibly strong, regardless of the material they're made out of, because they disperse stress throughout their entire shape. If the rolled-up piece of paper were a perfect cylinder, the strength would be even stronger! This is what we strive for, by making the the tube on a mandrel. Eventually, as you approach papers as light as Japanese tissue, the cohesion in the paper fails and the tube walls collapse under the lightest weight. These ultra thin walls can be supported with rings made from pink insulation foam, but they also add weight to the model. Ultimately there is a point where it is better to go with a slightly thicker or heavier paper simply for the wall strength. That is also what we are looking for – the edge of the envelope. Examples of these light/strong/smooth papers are: Graph Paper, Newsprint Sheets, Manifold Paper, Vellum, and even Printer Paper, but this tends to be heavier. Most papers come with the weight listed per ream (500 sheets) – lower the number, lower the weight of the individual sheet. You want smooth surfaced papers, not sheets like tracing paper or onion skin tissue. Smooth papers also lend themselves nicely for printers to add graphics and labeling. Of course, inks and toners do add weight, just like paint.

1/2 Cup of Coffee supported by 1wrap printer paper tube

Lets make an **S3 (parachute)** or **S6 (streamer)** duration model.

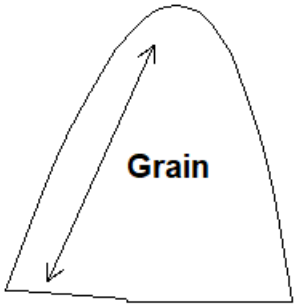
First place to start is to get a 40mm nose cone. Apogee is the only place I know selling them, but making them yourself with

Apogee's FAI 40MM Vacuformed Styrene Cone

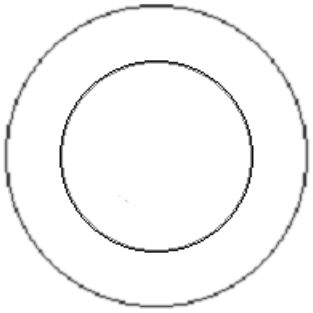
S3 and S6 FAI Models

1 inch

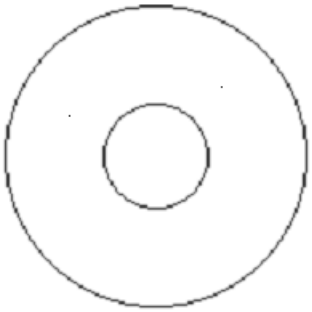
Fin
(make 3)



25-40 CR



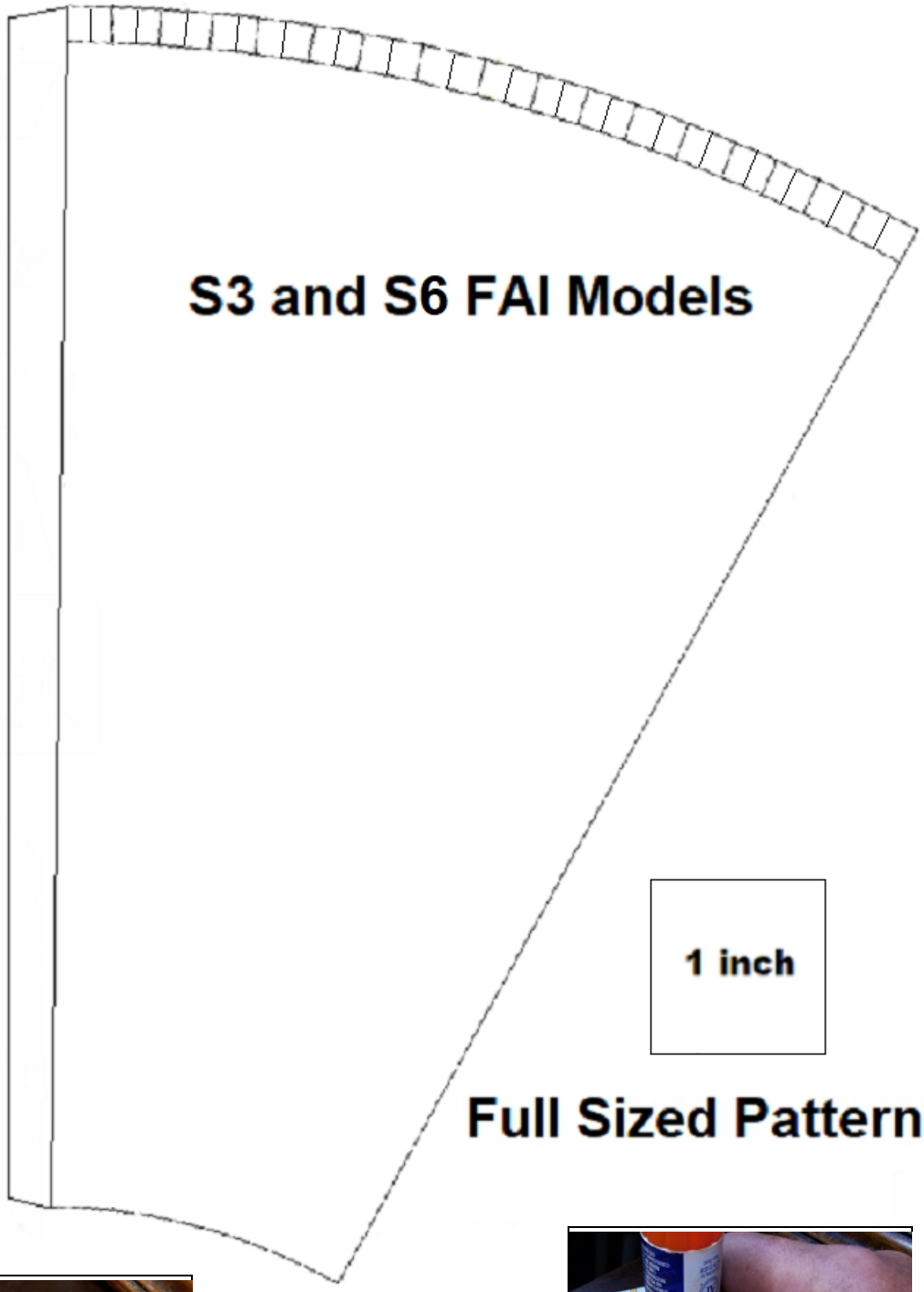
13-40 CR



Insulating (Pink) Foam
or Index Card

Full Sized Pattern
Check using 1" square

a vacuformer is not unreasonable. If you don't have one, check with a friend or, maybe your Dentist at your next check-up <G> or just go to:
ApogeeRockets.com. I prefer the rounder tip: model 20061, but you may have to put it in the search window. Of course, you could always top your model with a paper cone.
Next, select your paper – choice is yours. But if I could suggest, try some light printer paper from the stationary store. Colored printer paper is cool, but seems to be a bit thicker and heavier. Copy the patterns shown to the right on this page and the previous, either on a photocopier or by scanning into your computer. In your graphics program (ex: Paint) add any graphics you want to see on your model. Print and cut out the patterns. Be sure the 1" square on the pattern page turns out to be exactly 1 inch – this insures your patterns are the correct dimensions.
I like to "pre-curl" my paper parts. This way they wrap easier around the mandrel – but more importantly – the edges will lay flatter and are much easier to seal. Simply turn over your mouse pad, foam rubber side up. Take a dowel or small diameter brass tube or rod and roll it in the direction along the back side (inside) of the panel. It must be done with heavy pressure to initiate a curl in the panel. When the paper can keep a crescent shape on its own, you have imparted enough curl to begin wrapping your tube or tail cone.



Because structural strength comes from the tube/cone, you need to be sure the joint between wrapped edges is smooth, with out lumps or interruptions of the overlap. I've used both tape and glue to bond this joint. My preference is for Stick glue, but it can be tricky. White glue, epoxy and Ca+ soak into paper and tend to cause the joint to ripple, but stick glue can be applied concisely, accurately and creates an extremely smooth joint.


<u>Pre-Curling</u> paper patterns can help the overlap align & lay flatter

The key to using it is to place a second piece of paper as a glue barrier along the overlap line on the pattern. If you apply glue past this line, you will end up gluing your tube or cone to the mandrel (don't do that! See photo right. Form both the tail cone and the body tube separately and remove them


Mask the pattern so that glue is applied *<u>Only</u>* **to the tab overlap**

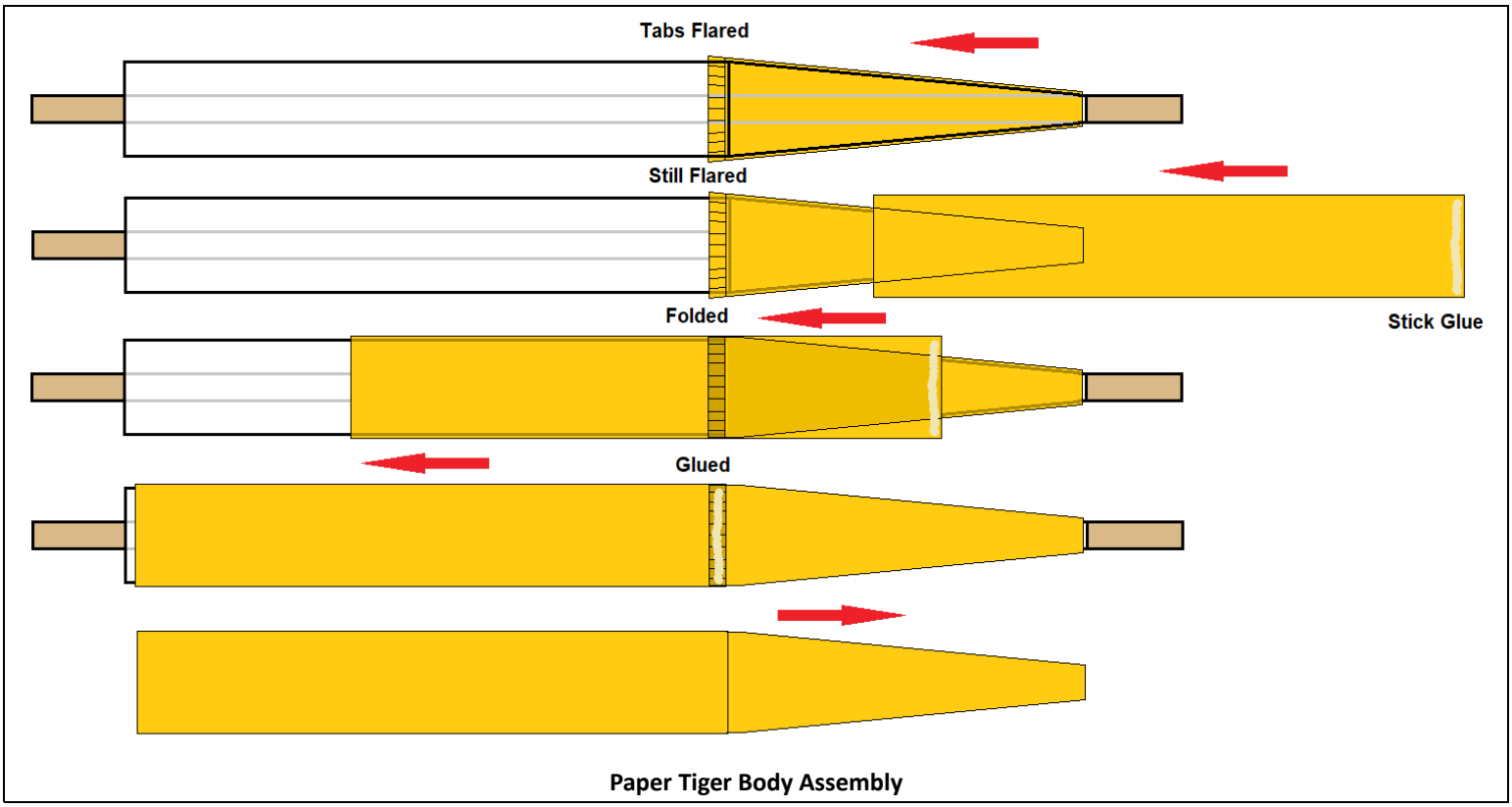
from the mandrel.

The large end of the tail cone has short vertical release slits. These form tabs that are “fanned” and facilitate a flat, smooth, compressed telescoping joint when joining the cone and upper body tube. Do not make these cuts longer than the cone transition point – you want them to end up under the body tube but not extending past the joint. This will only result in holes in the wall of the model. The body tube overlaps the tail cone in this area. Place the cone back on the mandrel. Slide the tube over the cone from the small end. The tube will compress the tabbed area to conform evenly. Slide the tube all the way to the angled transition as practice. Continue in the same direction to slide the tube off. This will stretch the tube for easier joining. When ready, coat the last 1/4” inside of the tube bottom that will be positioned over the cone tabs, with stick glue. Slide it into position over the cone and burnish the joint area to assure good adhesion and a sealed tube wall. Then remove it with a slight twist off the small end of the mandrel.

Next, check your nosecone fit. All it needs to do is sit on top of your body. To center it add a shoulder made of a ring of printer paper. It needs to be “light” not “robust.” Add a loop of thread glued to the inner wall as your “screw eye” attachment point.

Now we have to ask: Are we building a Parachute or Streamer duration model? There are some slight differences between the two : the length of the motor tube. You have a nosecone 58mm long, a body 250mm long (complying with FAI dimensions,) and a tail cone 170mm long for a total length of 478mm. You still need 22mm to meet the minimum 500mm length – this will be the length the motor tube sticks out the aft end. You will mount your fins on this tube as well as a portion of the tail cone. Mark this length from the end of a section of BT-5.

Since the tail cone was assembled concentrically on the mandrel, we can use the open tip to center the motor tube, but we need a centering ring inside to do the same. You can make one from index card stock or thin cardboard from the 13-40 CR pattern. Even lighter rings can be made from insulating (pink) foam using a compass. The position of this ring inside, is what differs in a parachute vs streamer model. For a parachute, where you want the maximum room for a l-a-r-g-e parachute it is located at the transition flexure between the straight body and the tail cone. This makes the motor tube for a parachute model with index card ring 170+22+5= 197mm. The extra 5 mm is so the ring can sit atop the tail cone paper tabs used to glue the tube and tail together. They overlap the last 5mm of the tube. Forcing a ring over them (unless loosely fit) could potentially disturb your stick glued paper tabs.

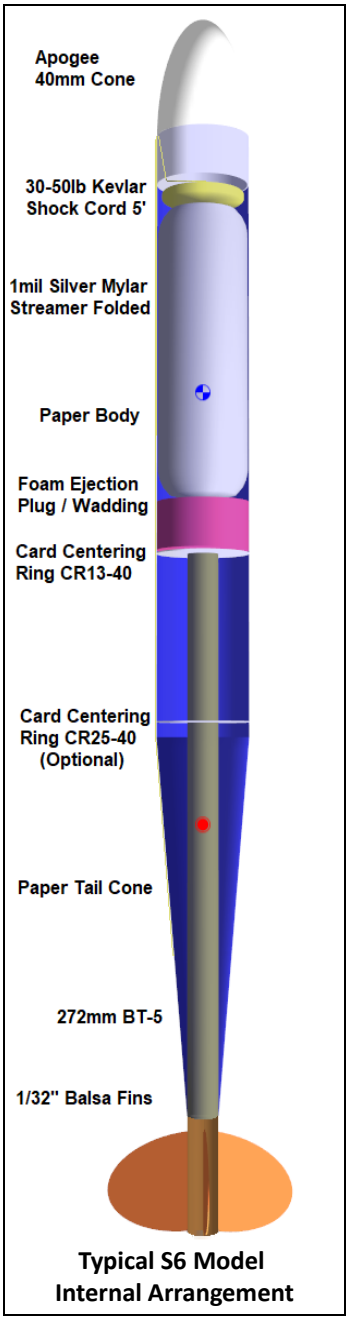


Paper Tiger Body Assembly

For a streamer model, you don't need as much cargo space – and you do want to keep the weight of the streamer forward just behind the nose cone for balance and CG/CP purposes (you remember them?) Normally FAI flyers use 5 to 5.5” wide streamers, requiring 140mm of payload behind the nose cone. Add a good 10mm for the length of your nose shoulder and another 20mm for wadding, making the required space 170mm, leaving 80mm of empty space below your recovery system. So, the length of the motor tube with index card ring on a streamer model would be 80+170+22= 272mm of BT-5. The BT-5 may be the heaviest part of the Paper Tiger – but there are methods to reduce this as well, (which could be discussed in a future article.)

Mount the Motor Tube by first gluing the centering ring flush with the top end of the motor tube, the one opposite where

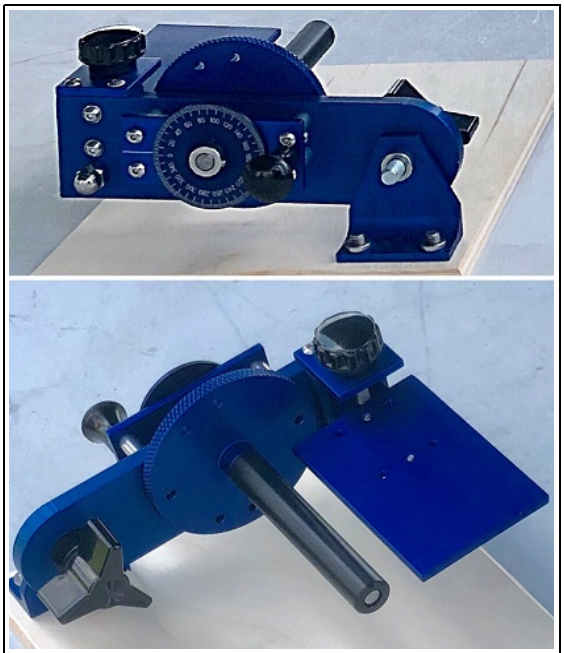
you placed the mark at 22mm. Test fit the motor tube assembly in the body by inserting from the 40mm end. Make a small mark where the final location of the (top) ring will be and remove the motor tube assembly. Using a strip of long scrap balsa or a thin dowel dipped in glue, spread a small amount of epoxy inside the body just above where the tabs of the tail cone end. Place the centering ring with the larger center hole (25-40 CR) over the handle of the mandrel's 40mm end. You will use the butt end of the mandrel to position the ring. Align and slide them both into the 40mm body intp position above the tabs. Quickly remove the mandrel. Allow the glue to set. (Hopefully you used 5-10 minute epoxy...) Once it has, using your glue spreading stick, again spread a small amount of epoxy inside the body just above where the upper ring will be positioned. Spread a light ring of glue on the motor tube at the 22mm mark. Slide the motor tube into the body as you tested and through the ring with the large hole and out the end of the tail. You can place a long smaller diameter dowel through the motor tube to help guide it as it enters and slides through the body. It will help avoid hitting the ring already inside and prevent glue getting in unwanted places if you hit the inside walls. Grab the part of the motor tube protruding out the back and make the final positioning by twisting back and forth to tease it into the model. As the ring slides rearward it will engage the glue ring inside, embedding in it. There should be no need to glue the upper surface of the ring with your glue on the dowel again – it is messy and adds weight. Please remember: You are fabricating a lightly constructed model for one, two, m-a-y-b-e 3 flights. The technique in international competition is to use a ***Fresh*** model as often as you can. Normally, only one model needs to be flown twice – 3 are needed for an event competition! You could swap out the nose cones, but make a bunch of bodies. After all, they're only made of paper!



Typical S6 Model Internal Arrangement


You'll end up with a whole lot of them...!

Fins: You want them light, stiff and airfoiled or at least sanded to round leading and trailing edges. The best way is with 1/32" light, contest grade balsa, or as close as you can get. Seal the surfaces after sanding with a little Ca+ glue, then re-sand the fins to smooth them. They are 10-15% of your total drag, so make them smooth and slick. Attach them to the model absolutely straight – ***NO*** eyeballing – use a jig to insure they are on the center line, perpendicular to the motor tube and STRAIGHT! (got it? STRAIGHT...)


Use: Dan Harrison's *NEW* Rose Fin Jig clone- $400
Photos: Ole Ed Pearson

You now have an assembled model, with out a shock cord. This cord is usually made from either 30lb Kevlar (or 30lb Dacron fly-fishing line) and is mounted on the OUTSIDE of the model at its balance point. You want the model body to fall horizontally to provide the most resistance against the air as it falls. Simply insert an expended motor into position in the motor tube, tape it there (tape has weight). Tape a length of cord to the tail cone, about 25mm in front of one fin. Play with this position fore and aft, until the model balances horizontally. Once located, the short, trailing length of shock cord is Ca'ed to the tail cone back and along side of the fin. This is why it is important to attach it in front of and in line with one of the fins. Place a piece of Scotch tape just behind the balance point over the cord, which will help it from ripping off during deployment. The shock cord will likely get pulled rearward as the parachute or streamer is deployed. Run the cord up the outside of the body. Use a tongue depressor or similar shaped card or balsa to compress the recovery system to one side and slip the extra cord between the recovery and inner body wall to reduce tangling. Fly on 1/4A3's up to Full A impulse 13mm motors.


Trip Barber's S3A Model is well balanced (NAR)

THE LAUNCH RACK

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Artemis: Greek Godess of The Hunt and of The Moon, Twin Sister of Apollo and logo Matron of our Return to the Lunar Surface.