COMPETITION DESIGN NOTEBOOK

MIT ROCKET SOCIETY

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MIT Rocket Society's

COMPETITION DESIGN NOTEBOOK

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A special Edition of the
Journal of the MIT Rocket Society

Edited by Geoffrey A. Landis GL

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direct all comments or questions to:

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COMPETITION DESIGN NOTEBOOK

INTRODUCTION

This book is a collection of plans for competition rockets. Most of the plans are seen here for the first time, some are reprinted from the *Journal of the MIT Rocket Society*, and some are reprinted from the *Model Rocketeer*. Our purpose is to present a relatively complete set of designs for modroc competition.

I feel there is some need for such a book, partly to give the relative beginner a sourcebook for some competitive designs, partly to give the more advanced modellers a look at the types of designs the MIT section is flying, and partly as a retrospective to let us see what the state-of-the-art in competition design is.

All of the models here are from members of the MIT Rocket Society. All are proven designs. Most have won at large regionals or placed at NARAM. Many are US record setters. All are competitive designs. To provide a complete survey of current competition design, I have selected one model for each of the B/G and R/G events, and a representative sampling of models for altitude, streamer duration, eggloft, payload, and provisional events.

As important as design to the good competitor, however is building technique and flying strategy. Both are best learned by practice. To adequitely cover building technique would require another book the size of this. Strategy comes from experience, but certainly a few words on general strategy will help the beginner.

Reliability is the most important thing to doing well at contests. A design which would have worked well if it had worked won't win. Try to keep your designs simple and reliable. Practice. Test fly models before contests: it helps a lot. Analyse your failures: why didn't it work? How could it work better? Prepare before contests. Many contests fly a lot of events in a little time. Have your rockets ready, and your range box prepared with ignitors, wadding, engines for a second flight, etc. Fly twice in every event if you have time, but be sure to get a first flight in each event before making any second flights. Be prepared for all weather: and fly low-performance models when you see that other people are losing their models in the wind. Be reliable; this is worth saying twice. If it doesn't work it can't win.

Be a good sportsman, though; it does pay. Love thy fellow competitor .... most of them are pretty good guys. Model rocketry is fun!

Geoffrey A. Landis
Editor

Boost/Gliders: an overview

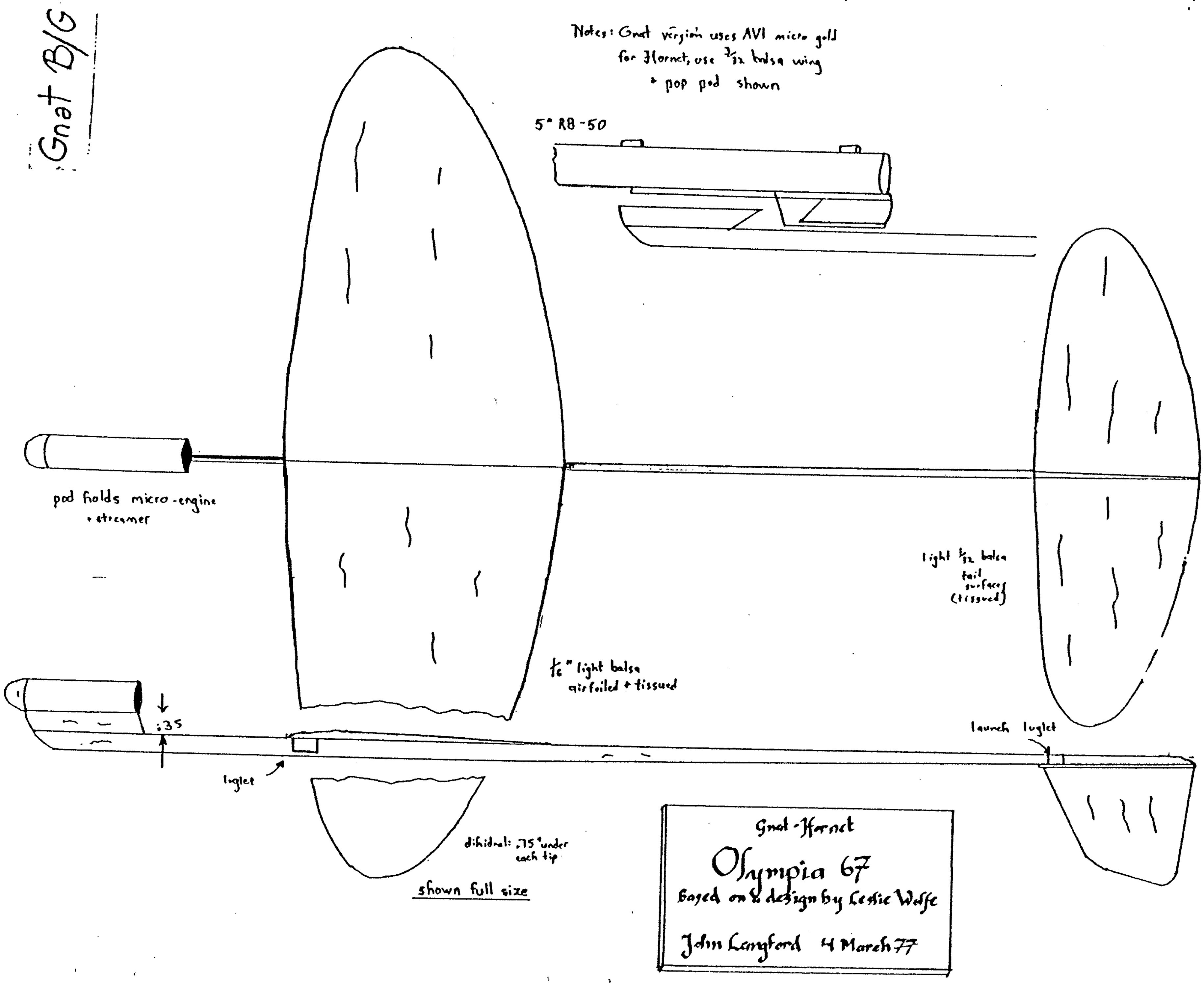
The gliders presented here are almost all winners of large regional meets. Olympia 67 is an example of a fixed pod gnat, designed for micro engines. This glider won gnat B/G at MARS XI; a slightly modified one won gnat at AARDVARK 5. Flanigan's hornet design is a good example of a small pop-pod'ed glider, and placed third at NARAM 18. Guppy's ultra-light Sparrow won at NARAM 16. Christopher's Swift design holds the US record from its winning flight at MARS IX. Bernard Biales' Hawk and Eagle designs set records under the old pink book, and are still favorite designs around the MITRS. The hawk makes a fine handlaunch glider, too. My own condor, Seraph, has not flown in competition, but should be more than competitive with anybody else's design. The original was designed for a D12 and two C6's plus tandems, but I would suggest you fly it with an E11.8 now that these are available. In condor, by the way, your best contest strategy is to use minimum possible power for your first flight, but to go for broke on your second flight if the first flight qualified.

In construction, strength versus weight is an all-important trade-off. For the low power events, there is little doubt that making a glider as light as possible is the way to go. Use light balsa for wings, and light glue (such as Ambroid and Zap) for bonding. For the higher power events, keep in mind that shredding on boost does not help you win contests. Eagles and condors especially benefit much from sturdy construction. (eg., don't try to trim down your glider to reach Bernard's weight figure unless you are as good of a craftsman as he is.)

A good guide to selecting balsa for building light gliders is in the February 1975 Model Rocketeer. I suggest you read it.

We usually cover all of our gliders with tissue. This adds minimal weight, but yields maximum strength and increased visibility. Good tissue is hard to find, but is available in many hobby shops. Tissuing starts by finishing a wing with dope, and then sanding it smooth with 400 grit sandpaper. The side of the wing to be tissued is then spread with slightly thinned dope, and the tissue carefully placed on, shiny side up. Wrinkles are gently pulled out, and a piece of toilet paper damped with thinner is then rubbed over the tissued surface to bring the dope through. Then another layer of dope is spread over the tissue, rubbed in (with your finger), and excess removed by rubbing again with thinner-dampened kleenex. When this is dry, the overhang can be removed by sanding around the edges with 320 sandpaper, and edges which aren't stuck glued down with more dope. Repeat the process on the other side.

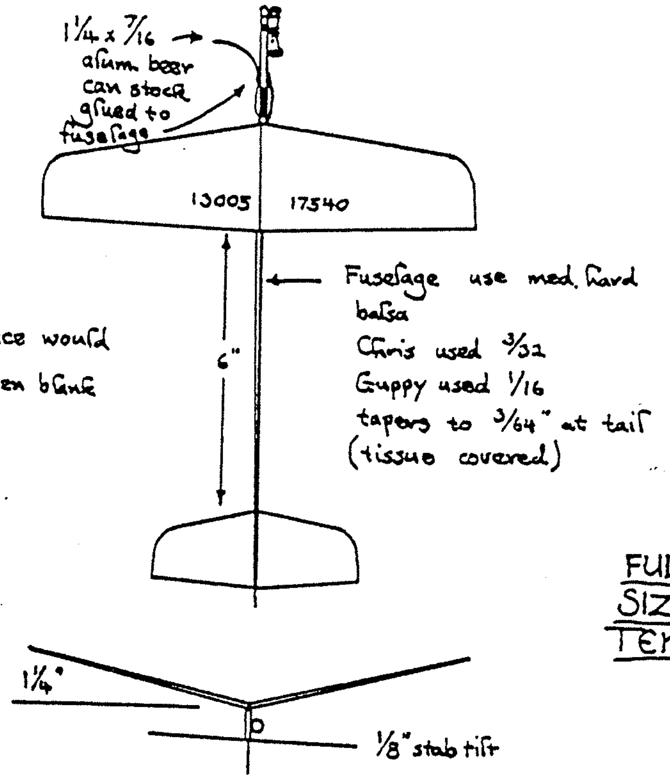
To round out the section on Boost/Gliders, we have a short article on pod construction and one on dethermalizers.


Gnat B/G
Notes: Gnat version uses AVI micro gold
for Hornet, use 3/32 balsa wing
+ pop pod shown
5" RB-50
pod holds micro-engine
+ streamer
light 1/32 balsa
tail
surfaces
(tissued)
1/16" light balsa
airfoiled + tissued
.35
launch luglet
luglet
dihidral: .75" under
each tip
shown full size
Gnat-Hornet
Olympia 67
Based on a design by Leslie Wolfe
John Langford 4 March 77

fish 'n Chips

a Hornet B/G design by the mutual agreement of Poot Face 1754☺ and Guppy 13005

3RD place Naram-18 Hornet B/G 144 sec.



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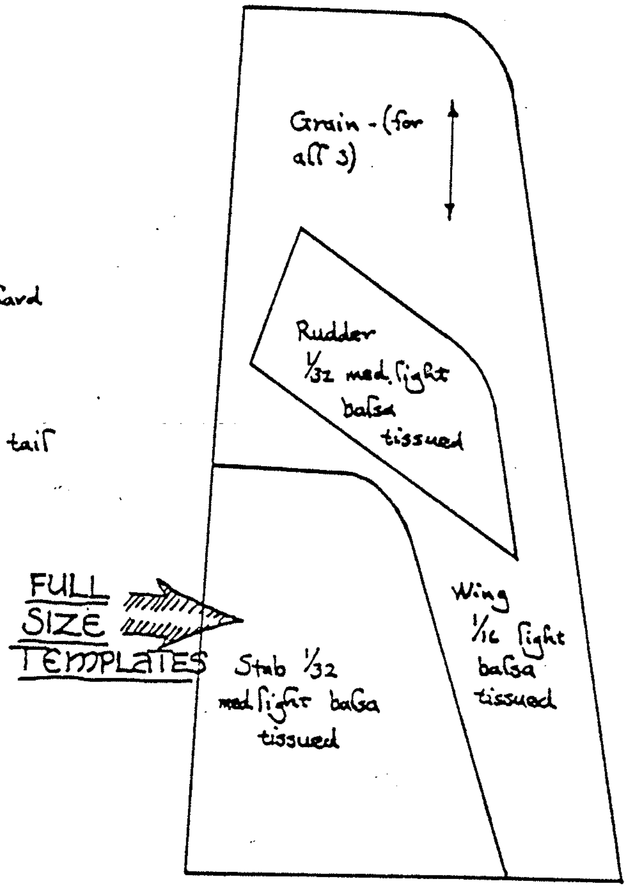
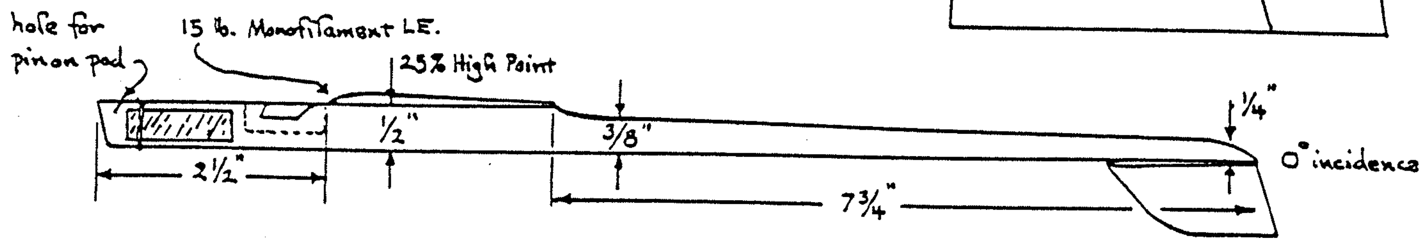
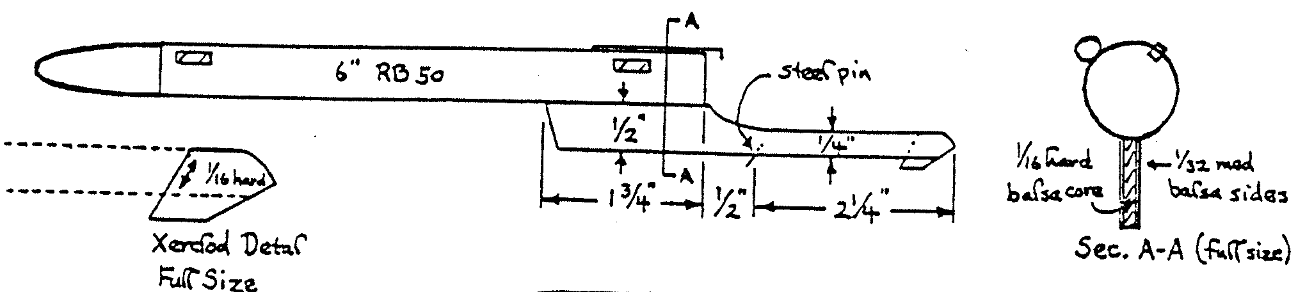
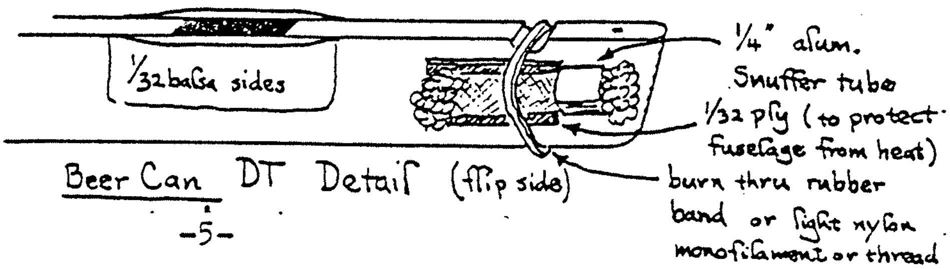






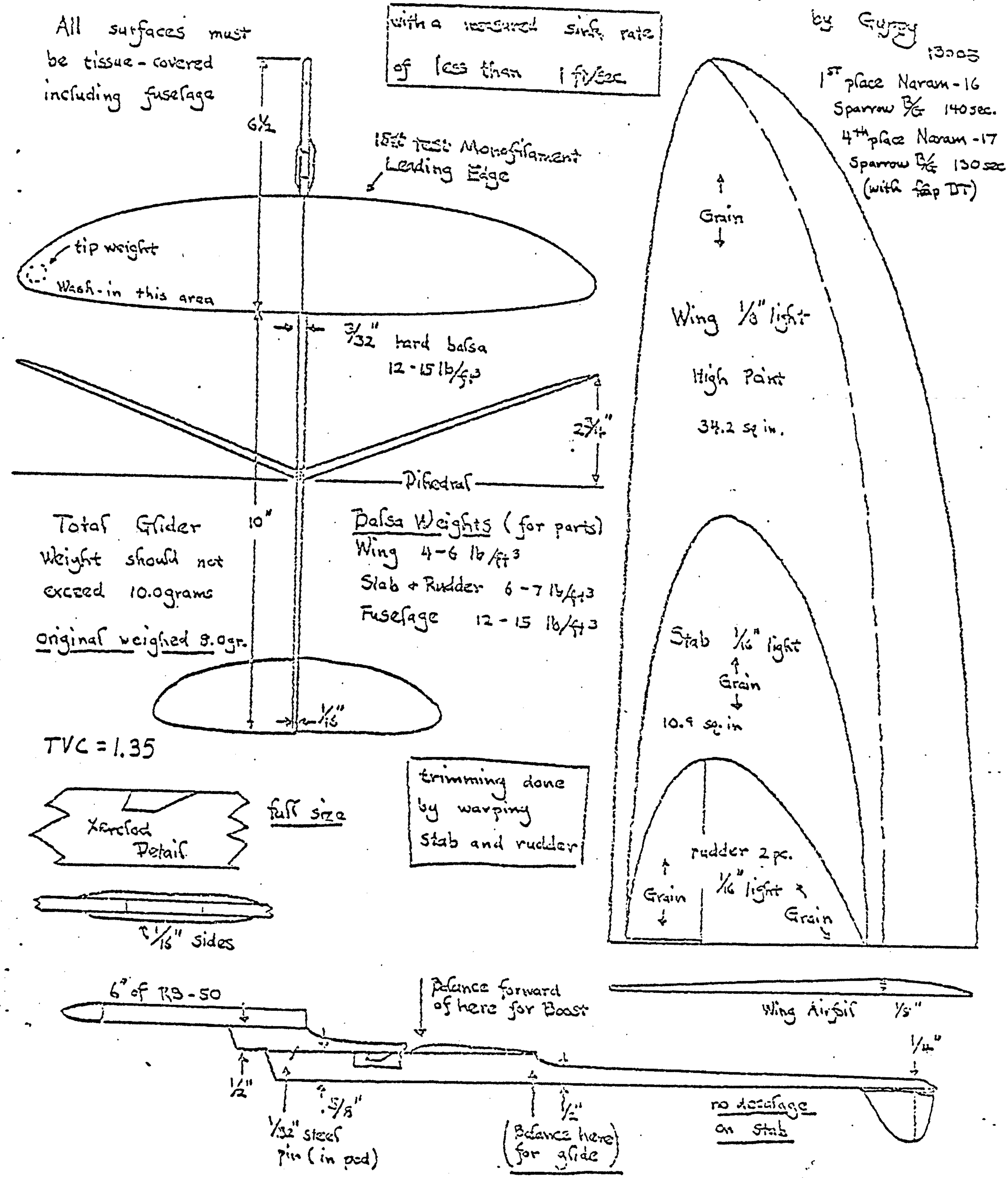


Beer Can DT Detail (flip side)

Guppy scripsit

A High Performance Sparrow B/G

by Guzzy 13003



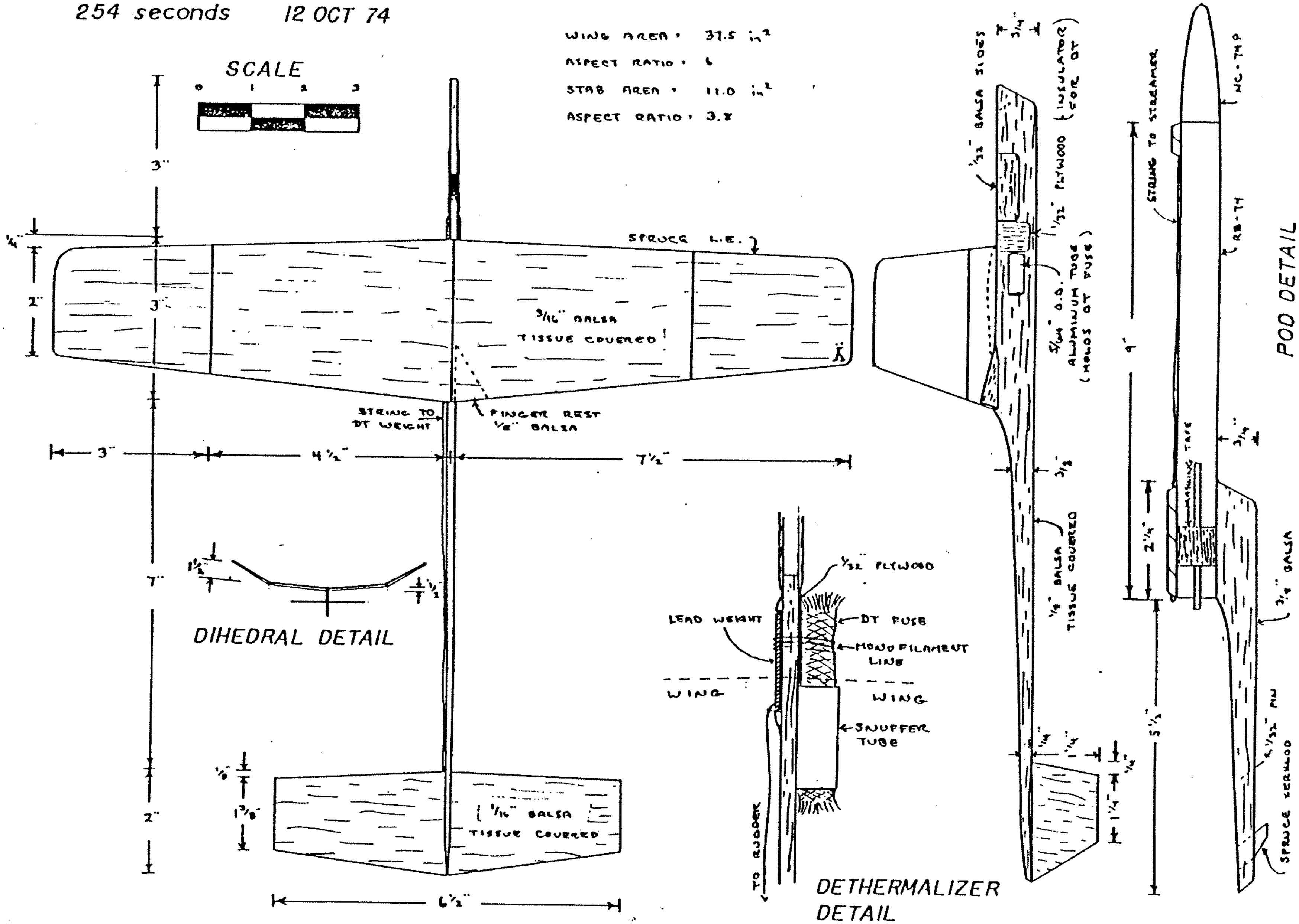
SWIFT B/G

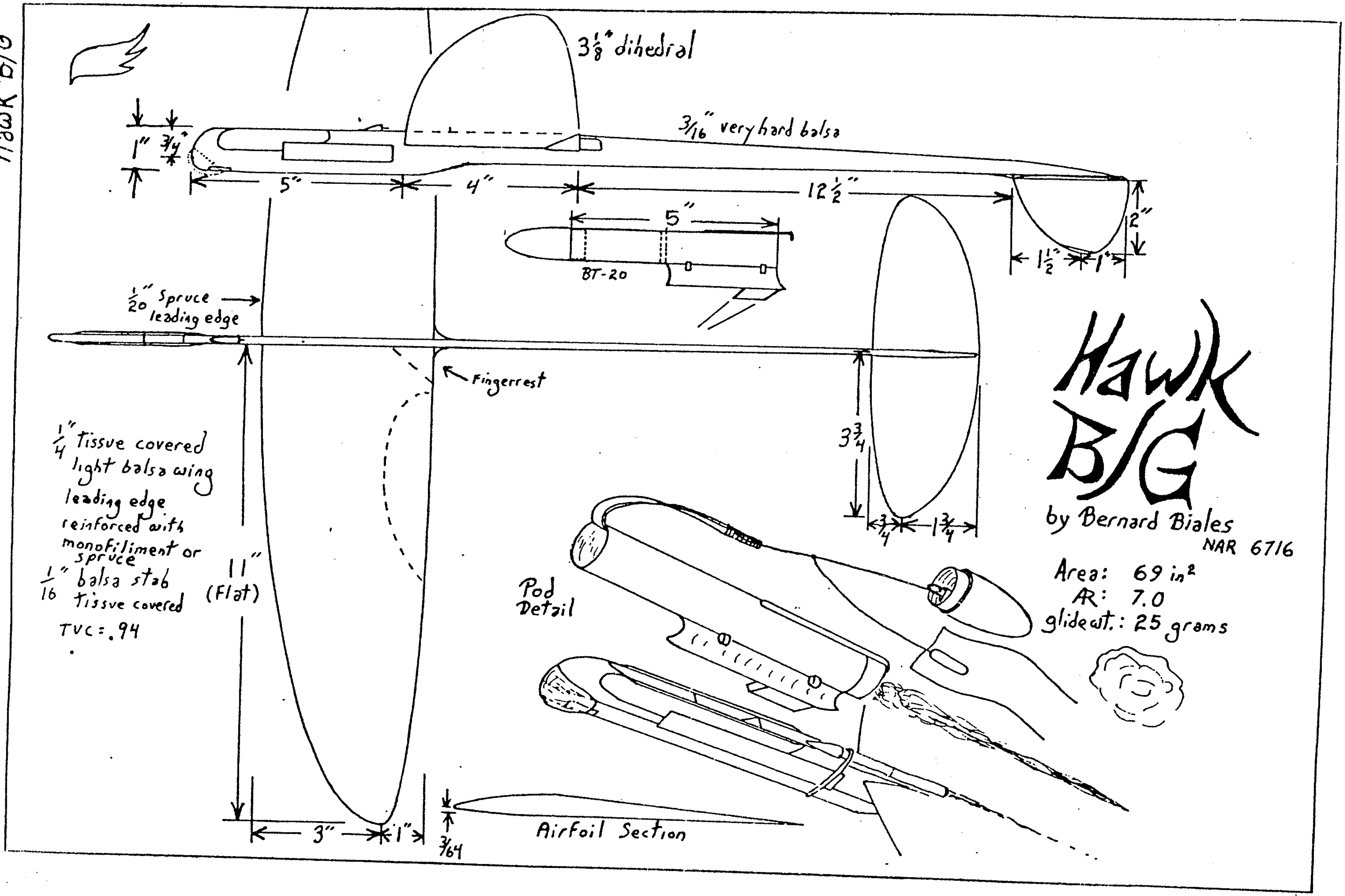
by Chris Flanigan 17540

254 seconds 12 OCT 74

GLIDER WEIGHT - 15.9 GRAMS
POP WEIGHT - 11.5 GRAMS
GROSS WEIGHT - 47.2 GRAMS

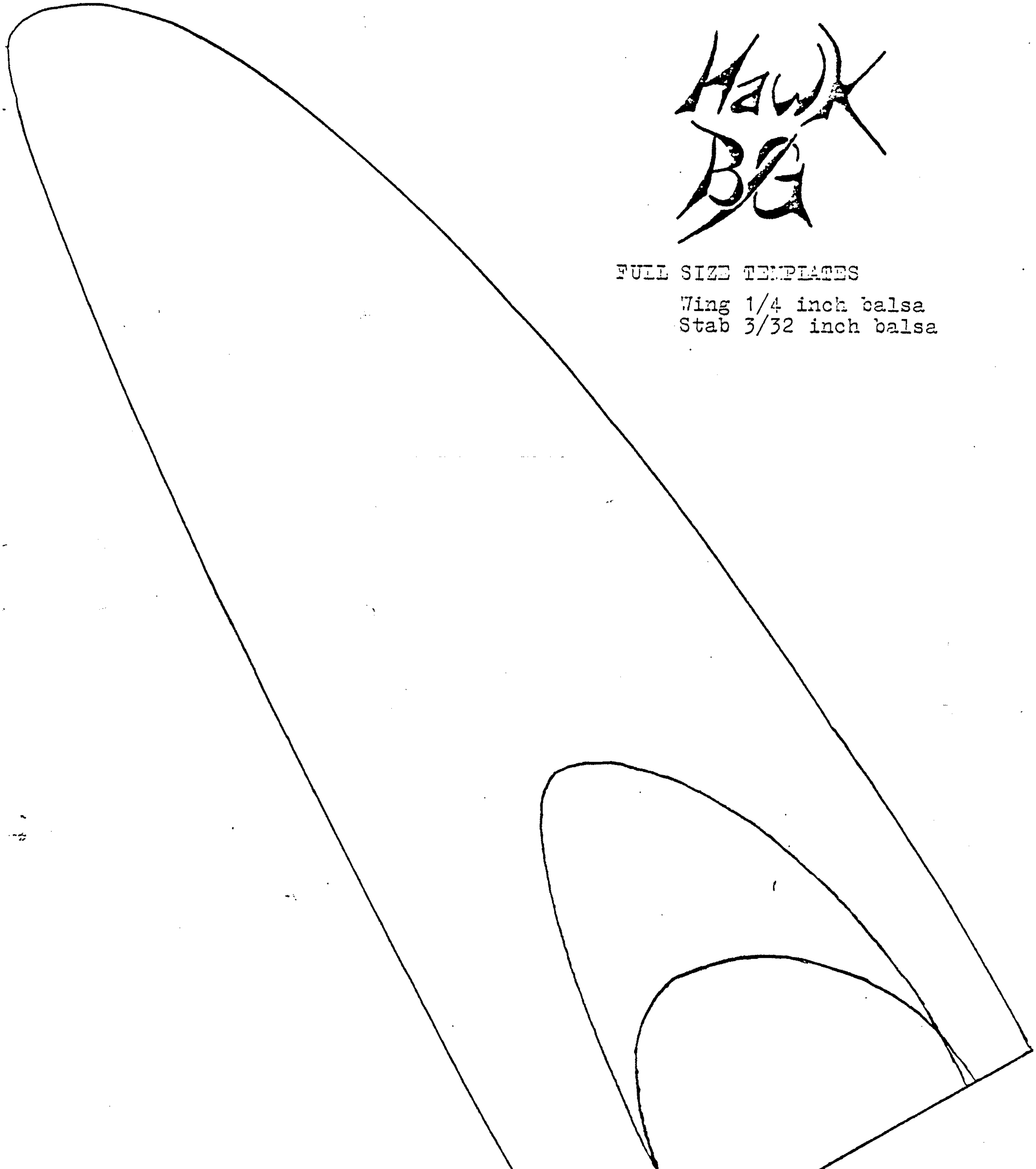
WING AREA : 37.5 in^2
ASPECT RATIO : 6
STAB AREA : 11.0 in^2
ASPECT RATIO : 3.8



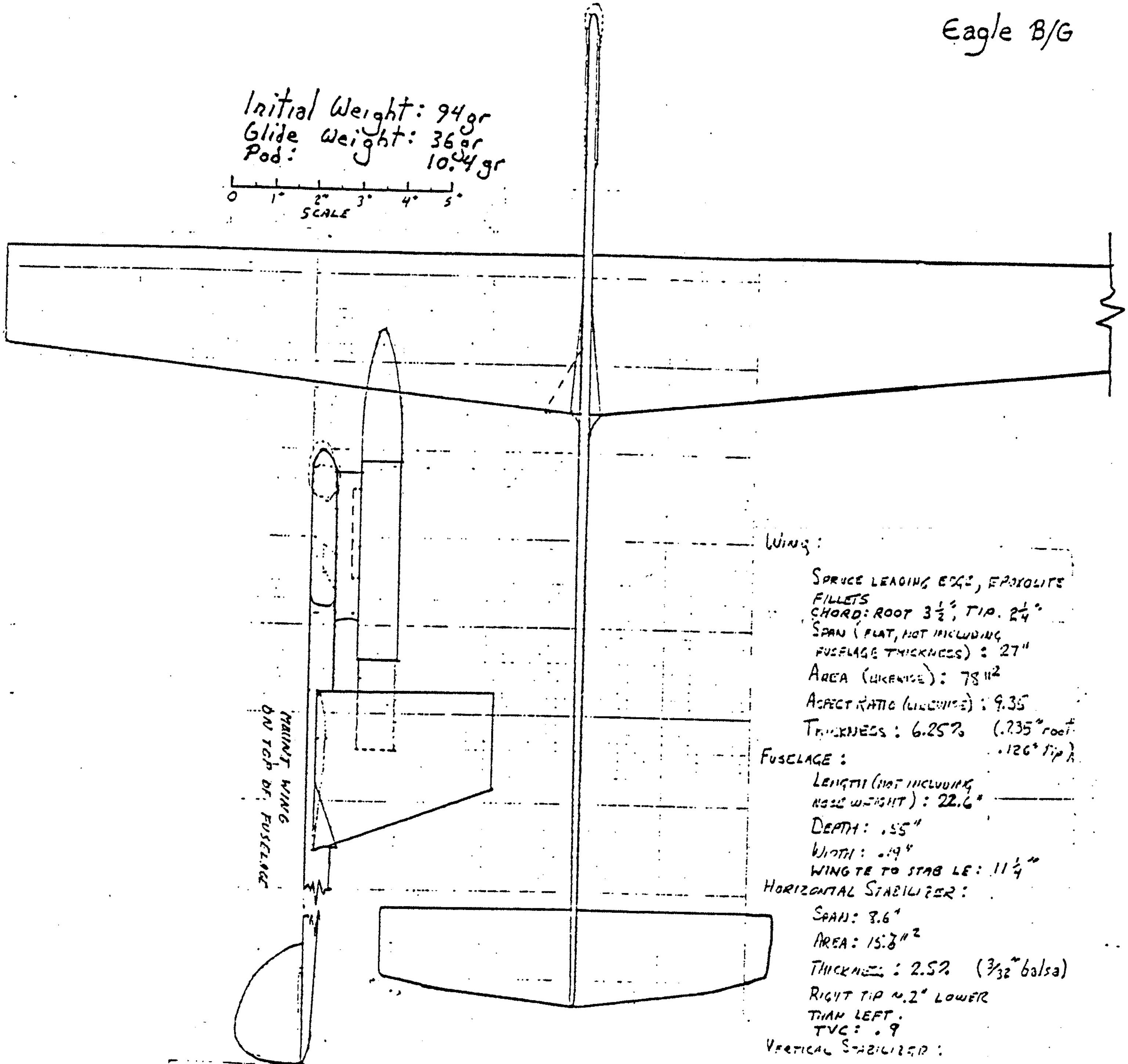

3 1/8" dihedral
3/16" very hard balsa
1"
3/4"
5"
4"
12 1/2"
2"
1 1/2"
1"
5"
BT-20
1/20" Spruce leading edge
Fingerrest
3 3/4"
3/4
1 3/4
Hawk B/G
by Bernard Biales
NAR 6716
Area: 69 in²
AR: 7.0
glide wt.: 25 grams
1/4" tissue covered light balsa wing
leading edge reinforced with monofiliment or spruce
1/16" balsa stab tissue covered
TVC = .94
11" (Flat)
Pod Detail
3"
1"
3/64
Airfoil Section

Hawk B/G

FULL SIZE TEMPLATES
Wing 1/4 inch balsa
Stab 3/32 inch balsa



Initial Weight: 94 gr
Glide Weight: 36 gr
Pod: 10.34 gr



WING:

SPRUCE LEADING EDGE, EPOXOLITE FILLETS
CHORD: ROOT 3 1/2"; TIP 2 1/4"
SPAN (FLAT, NOT INCLUDING FUSELAGE THICKNESS): 27"
AREA (LIKEWISE): 78 "²
ASPECT RATIO (LIKEWISE): 9.35
THICKNESS: 6.25% (.235" root, .126" tip)

FUSELAGE:

LENGTH (NOT INCLUDING NOSE WEIGHT): 22.6"
DEPTH: .55"
WIDTH: .19"
WING TE TO STAB LE: 11 1/4"

HORIZONTAL STABILIZER:

SPAN: 8.6"
AREA: 15.8 "²
THICKNESS: 2.5% (3/32" balsa)
RIGHT TIP ~.2" LOWER THAN LEFT.
TVC: .9

VERTICAL STABILIZER:

HEIGHT: 1.48"
AREA: 3.2 "²
AURROR 1/.. thick

POD:

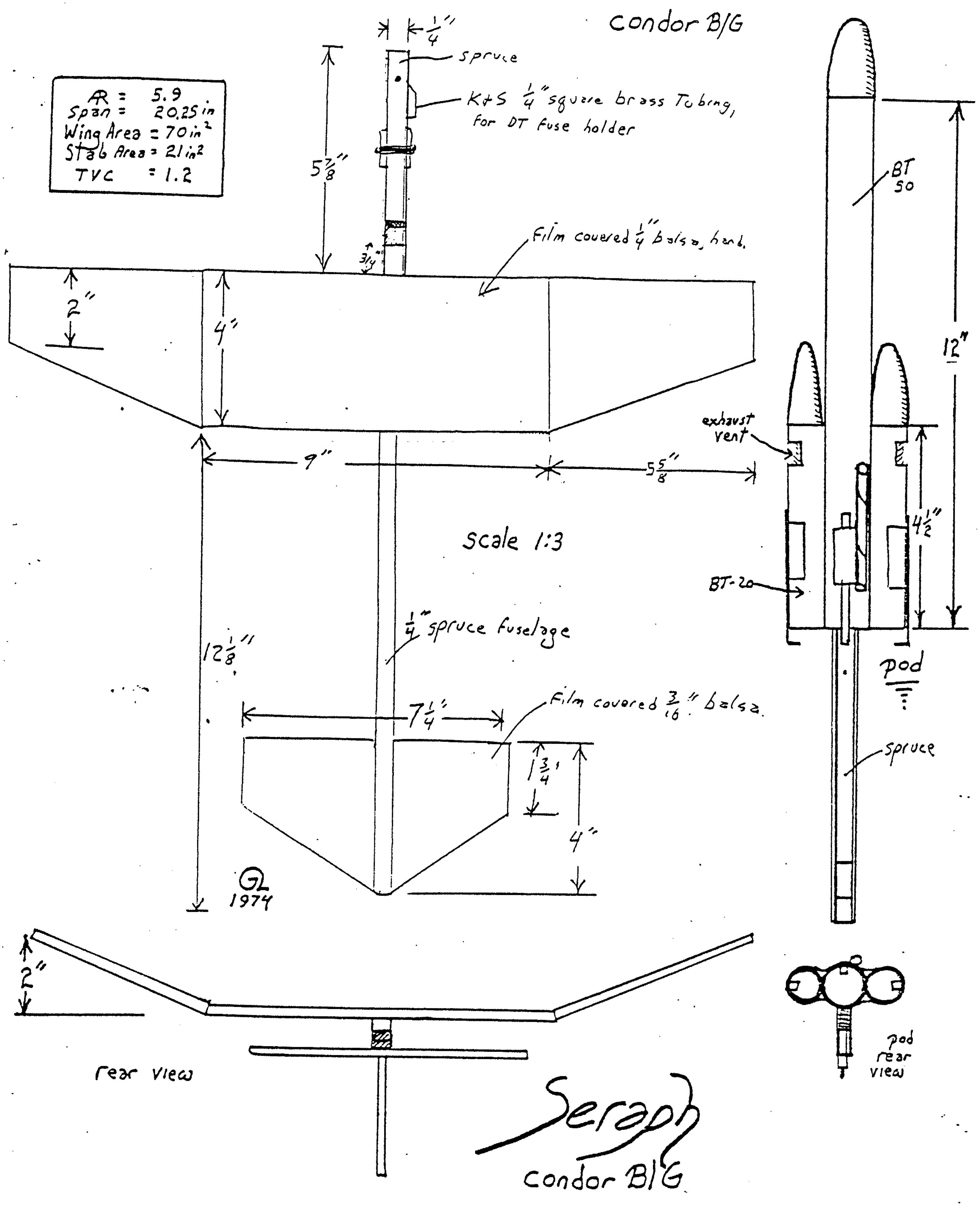
TOTAL LENGTH (– ENGINE): 7.5"
NOSE CONE: 3.0"
TUBE LENGTH: 4.5"
ENGINE PROJECTS BEYOND END: 2.04"
PARACHUTE: 8" HEXAGON w/ 1.7" ROUND HOLE
ENGINE: E5-2

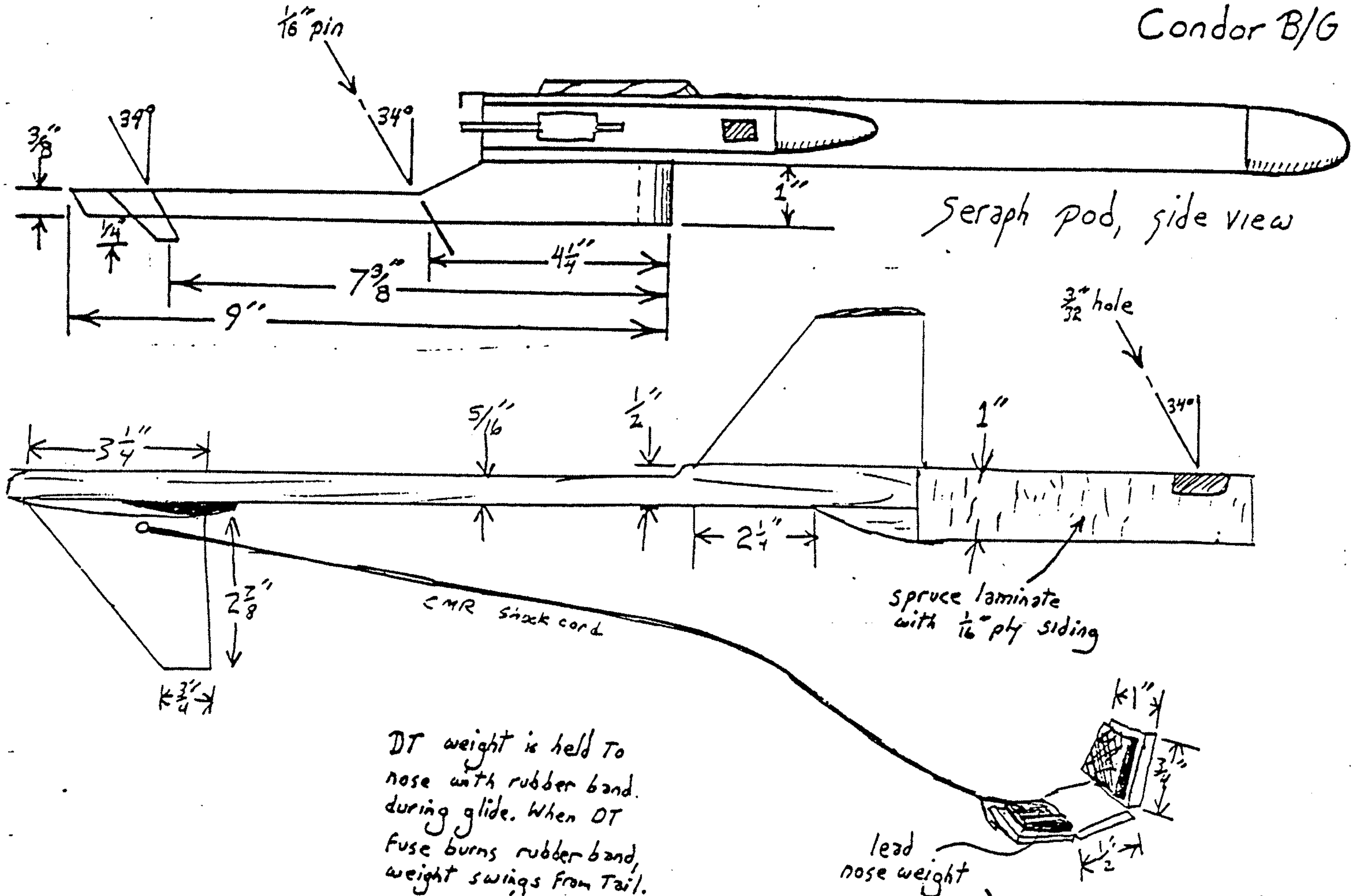
Go-Glo 78

designed + Built by Bernard A. Biales
Eagle B/G

RECORD ATTEMPT 6 FEB 71
249 SECONDS

BAB 7-2-71


condor B/G
1/4"
spruce
K+S 1/4" square brass Tubing, for DT fuse holder
AR = 5.9
Span = 20.25 in
Wing Area = 70 in²
Stab Area = 21 in²
TVC = 1.2
5 7/8"
3/4"
Film covered 1/4" balsa, hard.
2"
4"
9"
5 5/8"
scale 1:3
1/4" spruce fuselage
12 1/8"
7 1/4"
Film covered 3/16" balsa.
1 3/4"
4"
GL
1974
12"
BT 50
exhaust vent
4 1/2"
BT-20
pod
spruce
rear view
pod rear view
Seraph
condor B/G



SERAPH B/G
an approach to condor

Seraph

Condor B/G is certainly one of the more challenging competition events. Most condors use one of three general approaches: the parasite approach, the variable geometry approach, or the conventional B/G approach.

Parasite condors take advantage of the fact that they can be attached to a very stable, highly reliable booster vehicle. The parasite glider itself is usually small enough that it will not perturb the flight of the booster, which gives it the additional advantage of being small enough that the aerodynamic force on the glider is small. The main problem with parasites is that they go so bloody high that the tiny glider is hard to keep in sight.

Variable geometry gliders do something to the wing (flop, swing, pivot, etc.) to lower the air forces on it and thus make it less likely to shred and more likely to go up straight. Only problem is they are rarely reliable.

Seraph is an attempt to solve the problems of a conventional style condor. A thick spruce boom and monokote covered, hard balsa flying surfaces increase flutter-resistance and strength. Glue joints are well-filleted epoxy. The use of a far-forward boost CG (by using a modified Flanigan standard pod) makes the glider boost straight.

Seraph has never been flight tested in an actual contest, but test flights show that the system does work.

GL

THE

FLANIGAN STANDARD POD

by Chris Flanigan

Need to build a pop-pod for your new B/G? Let me recommend a Flanigan Standard Pod, the acknowledged favorite of the MIT Rocket Society.

The FSP has a number of advantages over your average pop-pod. The FSP has a long pylon which puts the glider's center-of-gravity during boost farther forward than normal, and this forward CG location helps give straighter boosts. The pylon itself is made from three layers of balsa, providing an easily-built and very durable structure. The xerclod (Piece X) and pin arrangement provides a secure latching and allignment mechanism for boost, but the system separates very easily at ejection (we almost never have a Red Baron due to xerclod friction). Finally, the FSP uses a relatively long length of body tube, which helps in quick and easy packing of the pod's recovery system.

Building a Flanigan Standard Pod is simple and straightforward. First start with the pylon. Cut two side pieces from 1/16" hard balsa (or 1/32" plywood) to the dimensions shown on the plan. Next make the pylon center sheet from 1/8" balsa and remove the slot for the xerclod. The xerclod is made from 1/8" spruce as shown. Now assemble the pieces. Glue the center sheet to one of the side pieces, secure the xerclod and remaining center piece in place, and glue on the other side piece. After the glue is dry, sand the pylon to round the edges.

The final step for the pylon is to insert the pin, a 5/8" long piece of 1/32" music wire (or a needle). Hold the pin with a pliers at a 45 angle to the pylon and push all but 1/4" of the pin into the pylon. The pin can be secured with a drop of "Hot Stuff". This completes the pylon.

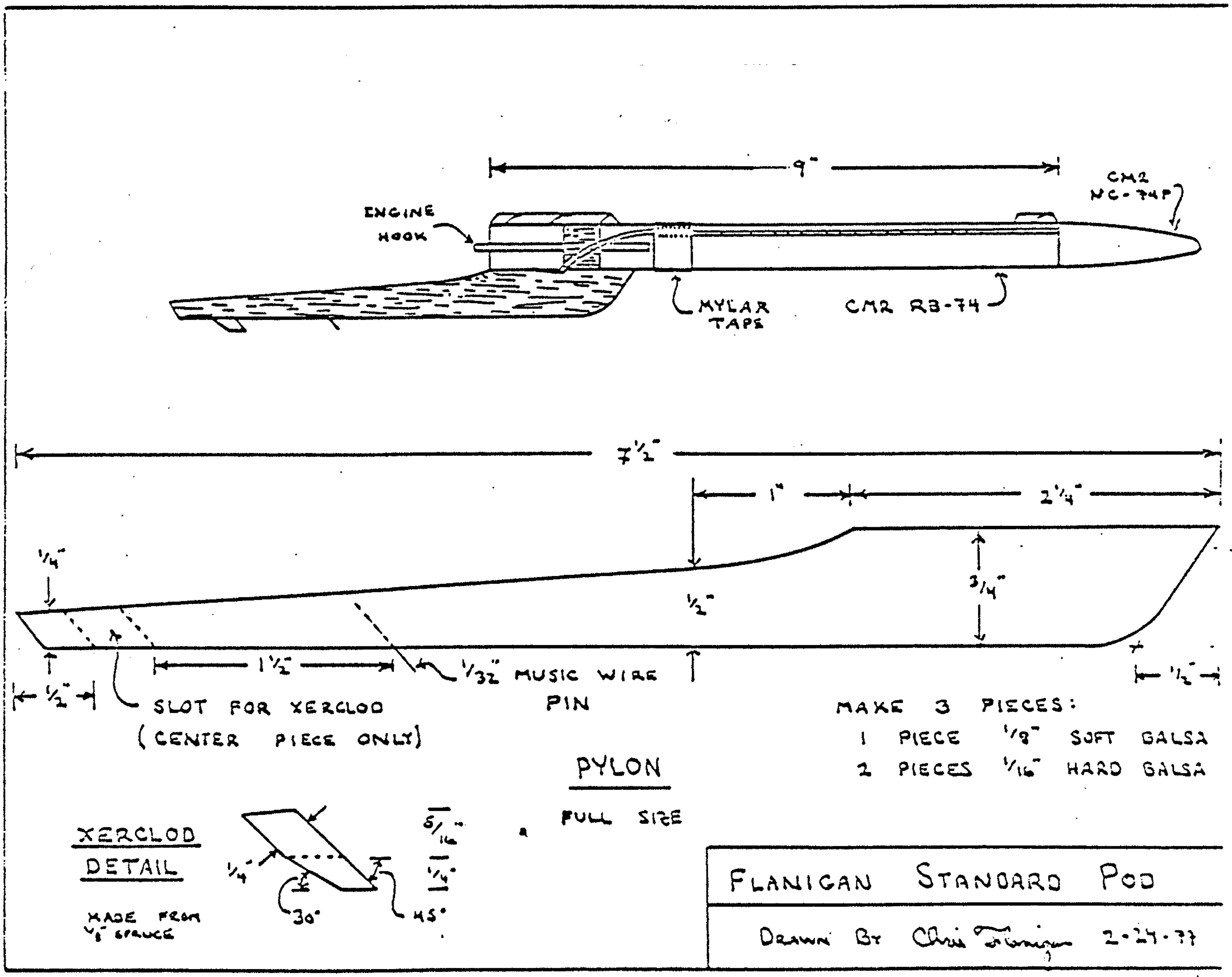
The body tube of the pod is a 9" length of RB-74 (or BT-20) with launch lugs glued on each end as shown. Glue the pylon to the end of the tube and on the opposite side from the launch lugs. An engine hook can be installed to make engine changing easier.

All pods need a recovery system, and the FSP is no exception. Either a streamer or a 10" parachute can be used, the streamer having the advantage of being less easily burned, but streamers also have the nasty habit of sometimes wrapping themselves around the glider. Experience will tell which system works best for you.

The recovery device is connected to the pod by a 12" to 18" length of Woolworth's 1/8" elastic or heavy fishing twine. The shock cord can be anchored in a variety of places, either internal or external. External mounting seems to work somewhat better as it gets the recovery device farther from the glider at ejection, preventing Red Barons. External mounting also has the advantage that it doesn't clutter up the inside of the tube, which makes prepping easier and more reliable. An external mount is shown on the drawing.

Attach a nose cone of your choice (such as an NC-74P) to the shock cord, add a little paint, and your FSP is complete. (Avoid getting paint on an external shock cord as this makes the cord brittle.) With proper care, a FSP can last <u>many</u> flights (our record is 47 flights on one pod!) and will usually outlive most normal gliders. Be good to your FSP, and it will serve you well and faithfully.

The pod presented works for standard size engines, but (of course) you can also build Flanigan Standard Pods for other engine sizes.



DETHERMALIZERS

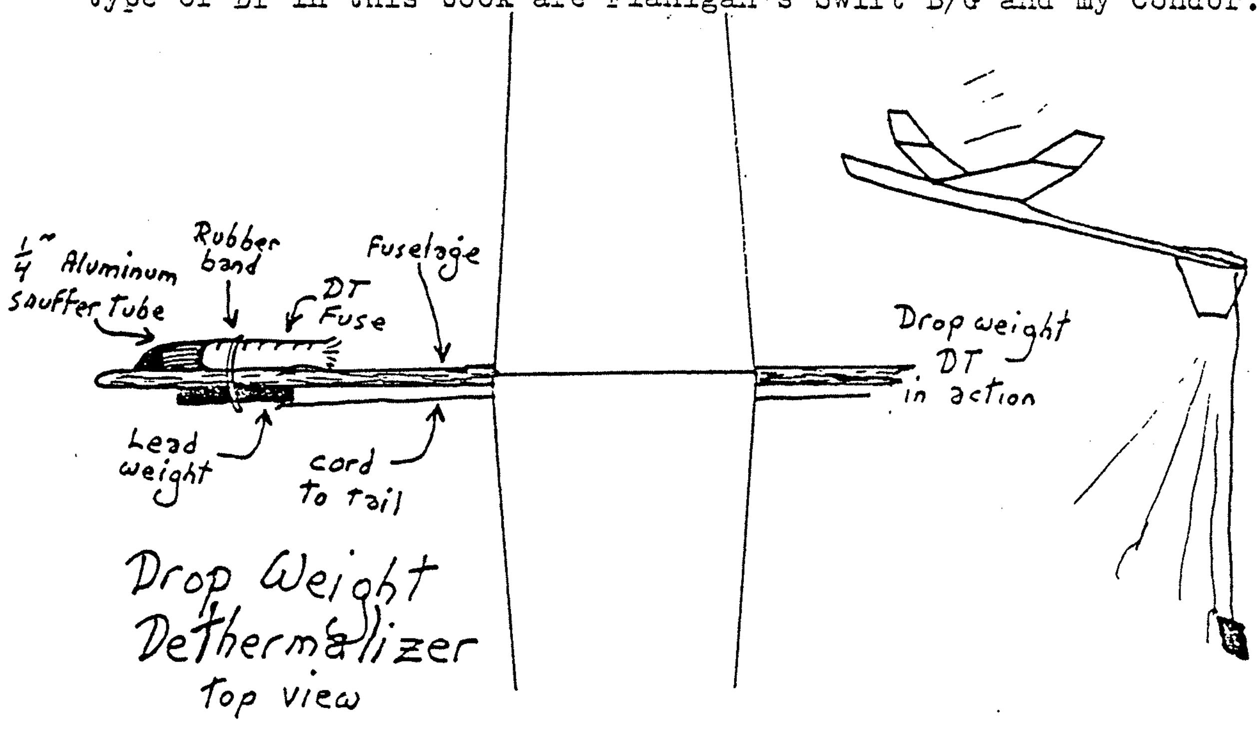
Geoffrey A. Landis

In many cases the advanced competitor may choose to use a dethermalizer on his glider. If you have repeatedly been in the position of seeing your model slowly drift downwind out of sight into the next county, or maybe out of sight straight up, it's time you think about using a DT on your model.

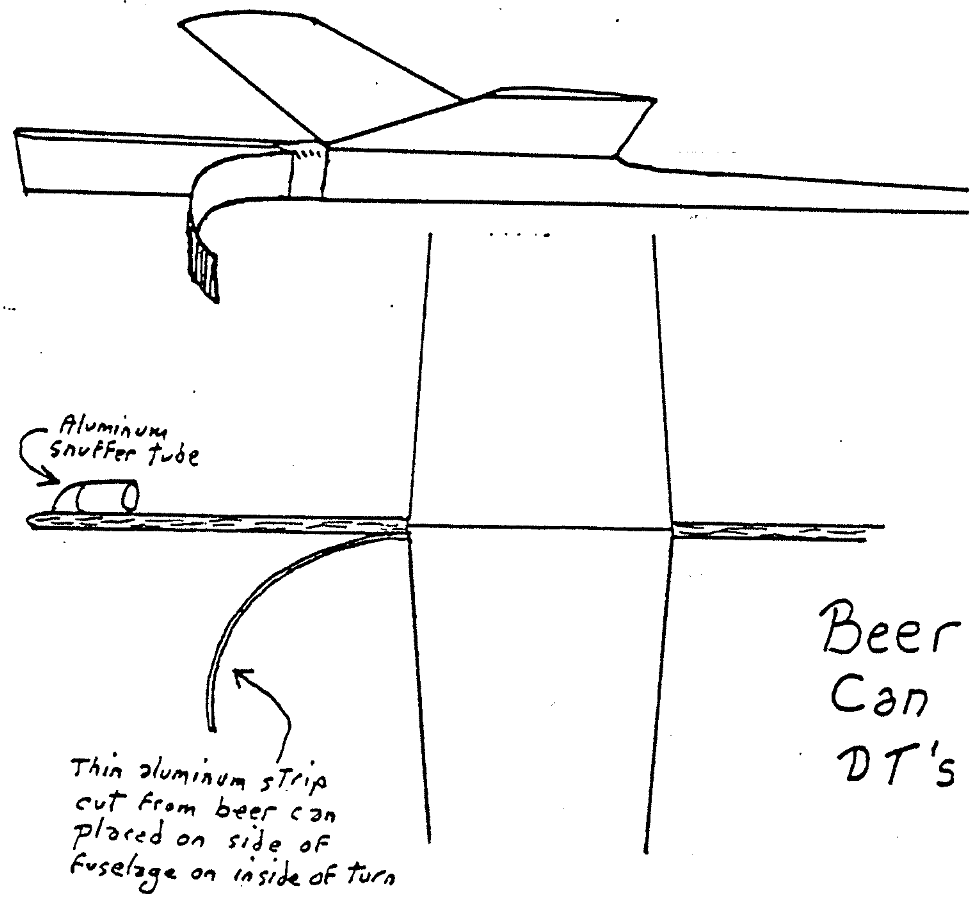
A dethermalizer is a device to bring a glider down after a set period of time. For small gliders, the only practical way to activate a dethermalizer is by use of a dethermalizer fuse (or DT fuse). This is a very slow burning fuse, with calibrated markings along the side. Most fuse is calibrated to one minute per marking, but in wind or during boost burning faster, about 30 seconds per mark. Good DT fuse is made by Sig, and is available in most hobby shops.

Every glider with a fuse-burning DT must have a snuffer tube (and Range Safety Officers should not pass models without one). This is a 1/4 inch aluminum tube which holds the fuse to the glider so that it does not fall away when the DT activates, and which snuffs out the fuse when it is through burning. Modelers using DTs should also take care to burnproof their model along the side of the fuselage where the fuse will run: a thin plywood plate or a thin layer of epoxy will work excellantly.

The simplest type of dethermalizer is the drop weight DT. In this DT, a rubber band holds the nose weight on. The fuse burns through this band, thus dropping the weight. The weight is attached to a cord to the tail, and swings from the tail to de-trim the model. Some examples of this type of DT in this book are Flanigan's Swift B/G and my Condor.

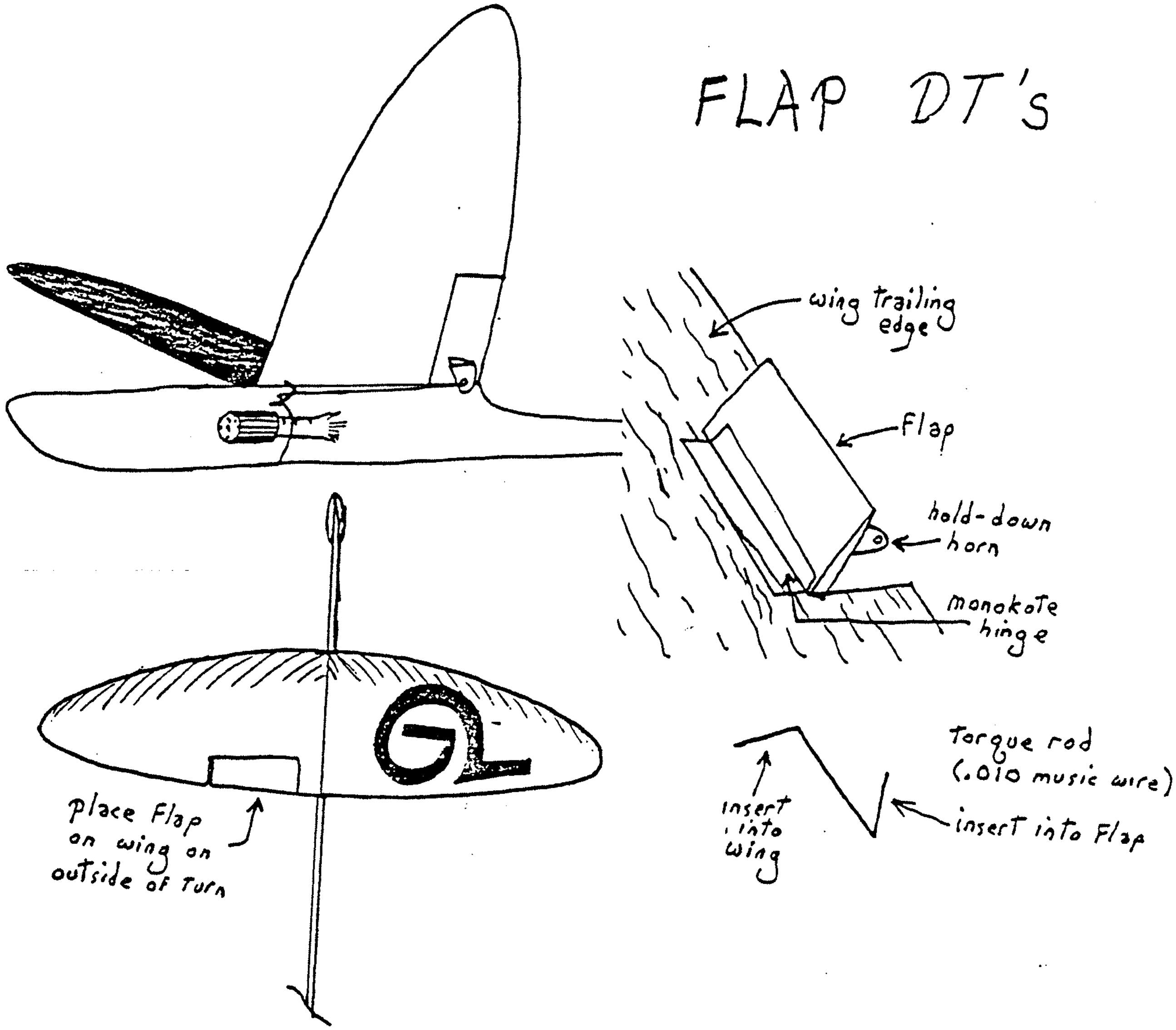


Another style of DT commonly used is the so-called "Beer Can" DT. After draining the beer from a lightweight aluminum can (this first step may explain the popularity of this type of DT) one cuts a strip along the circumference of the can, exactly the width of the glider's fuselage. This is taped to the fuselage at one end, the other end held flat with a piece of monofilement or a rubber band around the fuse. When the fuse burns, the strip of aluminum springs back to its original shape, creating a dragbrake effect which spirals the glider slowly down. The DT must actuate to the same side as the glider normally turns, else the effect will not be enough to bring the glider down. "Fish and Chips" uses a beer can DT.



A last type of DT is the Flap DT (drawings on next page.) In this DT a flap on the trailing edge of the wing pops up when the glider dethermalizes, again effectively spiraling the glider down slowly enough to cause no damage. A horn on the flap is usually attached to a monofiliment line which runs over the fuse to hold the flap down. A piece of elastic or a torque rod pops the flap up. The flap must be on the wing on the outside of the turn, to minimize the effect of down flap position on glide trim. Flap DT's work very effectively, but are a pain to prep.

An example of a flap DT is on Guppy's Swift R/G, Lumb Duck, showing that planning, not luck, is the way to win.



Other types of dethermalizers sometimes used are the pop-up tail and the pop up wing, which I shall not describe here.

The DT fuse is usually lit on the pad just before launch. It is most convenient to lite this fuse with either a cigarette or from a length of DT fuse which has been previously lit. The fuse can be lit on any point along the length for a longer or shorter burn time.

As yet only an elete few use DT's in modroc competition. If the use of DT's becomes widespread, there may have to be radical changes in range procedure to accomodate them. In addition, the use of DT's makes strategy much more complex. The expert flier must now be able to estimate exactly how long his glider can remain in the air before entering inaccessable territory, and watch the times of his competitors and set his DT slightly longer.

But it all becomes worth it when you return your glider for a first place, instead of vainly tramping through forest and field looking for the bird that "would have won."

Rocket/Gliders: an Overview

Rocket/Glider is certainly the most challenging event for the innovative designer, and there are a wide variety of approaches to the design strategy. Here we have a representative sample: a pop-elevator model, two slide pods, two slide wings, a sliding flow-wing, and a no moving parts glider. Except for Hig, our slide/flop wing, all of these are contest winners.

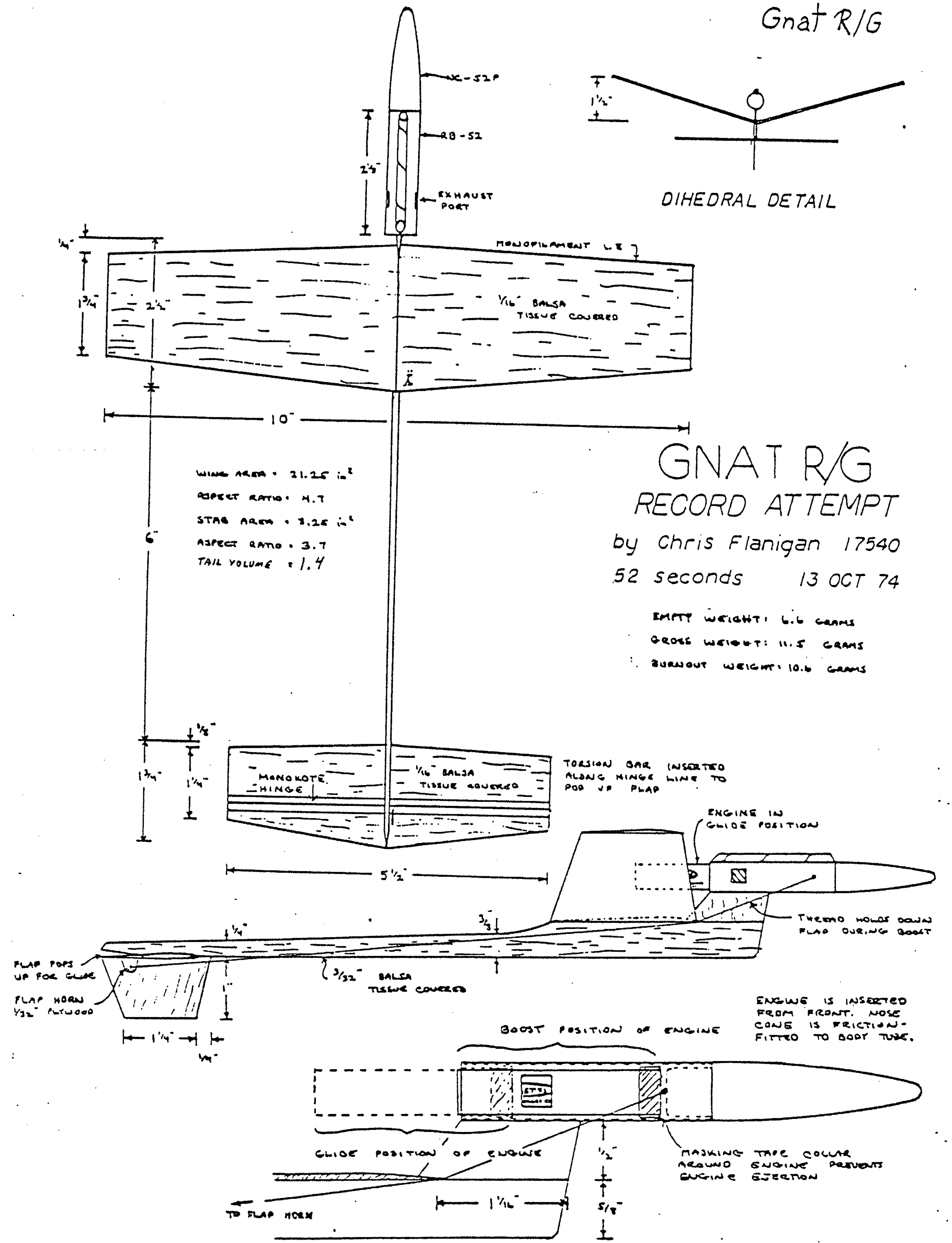
The gnat (which we reprinted from the rocket/glider design article in the 1975 Journal of the MIT Rocket Society) is an example of a moving elevator design, with a sliding engine for extra effect. It currently holds the US record from its winning flight at MARS VIII. The Nymph, a sliding pod design, since its publication in the Model Rocketeer has become an overwhelmingly popular design for all of the low power R/G events. It holds several US records and has taken innumerable places at regionals (and nationals) around the country. The Nadir, the sparrow R/G, is a later, cleaner version of the Nymph. A slightly smaller wing yields higher boost altitudes; the longer tail moment helps during boost and transition.

"Lumb Duck", Guppy's swift, is the winning design from NARAM 18. The wing slides from boost position to glide position along a 1/64" plywood rail. Another popular way to make slide wings is by building a balsa or plywood box around an untapered spruce fuselage and sliding the wing on this. Olympia 69 is also a slide-wing, this time featuring a built-up wing.

Julie Bird VI shows an interesting design strategy for high powered R/G. A long tail moment helps surpress looping due to engine offset. Here Paul Vandall carries this to an extreme to make a design strategy usually used only for low power events successful for eagle. In addition, he uses minimum power (10.6 nt-sec) and a very small wing to reduce the chance of shredding.

Hig is the only model in the design book which was not entirely successful. At this time, designing condor R/G's is most definately an art, not a science. I can count successful Condor R/G's on the fingers of one hand (both hands if I include condors which were not entirely successful but qualified anyway). The sliding flop-wing concept is a good idea for getting a straight boost and reducing the forces on the wing. The original Hig was R/C, but certainly could be built free-flight.

The flexwing designs are certainly a good bet for the provisional event of flexwing duration. They are extremely competitive in rocket/glide, except for reliability difficulties. Guppy's flexwing won Gnat R/G at MARS IX. Bernard's flying frog was the record holder in Sparrow R/G under the old pink book.


Gnat R/G
NC-52P
RB-52
2 1/2"
EXHAUST PORT
1 1/2"
DIHEDRAL DETAIL
1/4"
MONOFILAMENT L.E.
1 3/4"
2 1/2"
1/16" BALSA TISSUE COVERED
10"
WING AREA = 21.25 in²
ASPECT RATIO = 4.7
STAB AREA = 8.25 in²
ASPECT RATIO = 3.7
TAIL VOLUME = 1.4
6"
GNAT R/G
RECORD ATTEMPT
by Chris Flanigan 17540
52 seconds 13 OCT 74
EMPTY WEIGHT: 6.6 GRAMS
GROSS WEIGHT: 11.5 GRAMS
BURNOUT WEIGHT: 10.6 GRAMS
3/8"
1 3/4"
1 1/4"
MONOKOTE HINGE
1/16" BALSA TISSUE COVERED
TORSION BAR INSERTED ALONG HINGE LINE TO POP UP FLAP
ENGINE IN GLIDE POSITION
5 1/2"
THERMO HOLDS DOWN FLAP DURING BOOST
3/8"
1/4"
FLAP POPS UP FOR GLIDE
FLAP HORN 1/32" PLYWOOD
3/32" BALSA TISSUE COVERED
1"
1 1/4"
1/4"
ENGINE IS INSERTED FROM FRONT. NOSE CONE IS FRICTION-FITTED TO BODY TUBE.
BOOST POSITION OF ENGINE
GLIDE POSITION OF ENGINE
1/2"
MASKING TAPE COLLAR AROUND ENGINE PREVENTS ENGINE EJECTION
1 1/16"
5/8"
TO FLAP HORN

MOVING POD ROCKET/GLIDER FOR GNAT, HORNET, and SPARROW R/G

THE NYMPH

Designed by Geoffrey A. Landis
NAR 14193

Many methods have been used to obtain a reliable, straight boost, good transition, and good glide from a rocket glider. Most frequently seen these days is the "no moving parts" rocket/glider, which usually sacrifices straight boost and transition for minimum weight, reliable performance, and good glide characteristics. Other methods seen include swing wings, flop wings, pop elevators, engine shifts, canards, and moving pods.

Just about as reliable as the no moving parts R/G, and with a far superior boost and transition, is the moving pod R/G. Moving pod R/G's have captured numerous places at many meets across the country, including NARAM. The Nymph, a Gnat through Sparrow R/G, has proven its reliability and performance at numerous regionals across the nation. It has yet to be beaten in Hornet R/G, although not from lack of opportunity.

The moving pod is made from CMR RB-50 tubing, which slides freely inside a pod mount made from CMR RB-52. An RB-52 stop at each end prevents the pod from coming loose. A rubber band taped to the front pod stop and hooked around the back of the pylon pulls the pod back during glide. During boost, a thread (pulled with a needle through the pod and pod holder, just in front of the engine) holds the pod forward. At ejection the thread burns through, letting the rubber band pull the pod back.

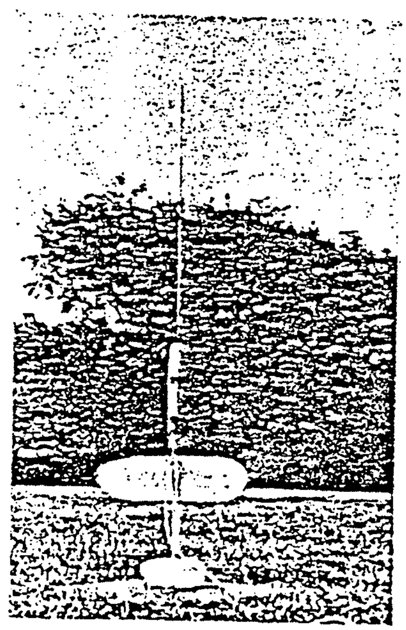
One other unusual feature of the Nymph is the three panel (rather than two) dihedral. Besides being easier to build, the three panel dihedral is also somewhat stronger. When building the wing, it is easiest first to cut the whole wing out of a sheet of 1/16" by 3" balsa, airfoil it, and then cut out the tip panels from the airfoiled wing, bevel the edges to be glued, and glue it together, remembering to prop both wingtips 2" up until the glue is totally dry.

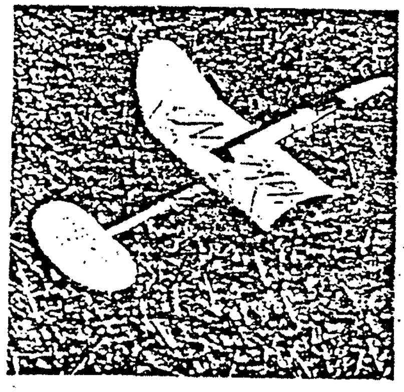
While the wing is drying, put the pod and holder together. If you have a CMR body tube cutter, use it; otherwise, make sure that you cut the edges of the tubes absolutely straight. Be sure to put the pod inside the pod holder before gluing the rear pod stop on. Any nose cone can be used, but if you use a CMR plastic one, you must coat the rear of the cone with epoxy to keep it from melting.

Next cut the boom from 1/8" by 1/4" spruce, and securely glue the wing on. Cut and airfoil the stabilizer and rudder, and glue them on, taking care that they are aligned. Fillet everything twice. Glue on the pod; put one 1/8" long piece of launch lug under the wing, one over the stab, and it's built. Finish it as you like it; I use one coat of sanding sealer and two coats of clear dope, sanding after each coat with extra fine sandpaper.

When it is thoroughly dry, put a spent engine in and trim it. There is no engine block. The engine is held snugly in place with a piece of tape wrapped around it. It is trimmed by moving the casing in or out. My gliders are usually trimmed with the engine sticking out about ¼". If it still stalls with the engine fully in, you can either cut the whole pod off and reglue it farther up, or put clay on the nose (the cheap and dirty method). Once you have a rough trim the only good way to get a really good trim is to fly it once or twice . . . I usually get my best contest flights on the second flight, after I have re-trimmed the glider for the specific weather conditions.

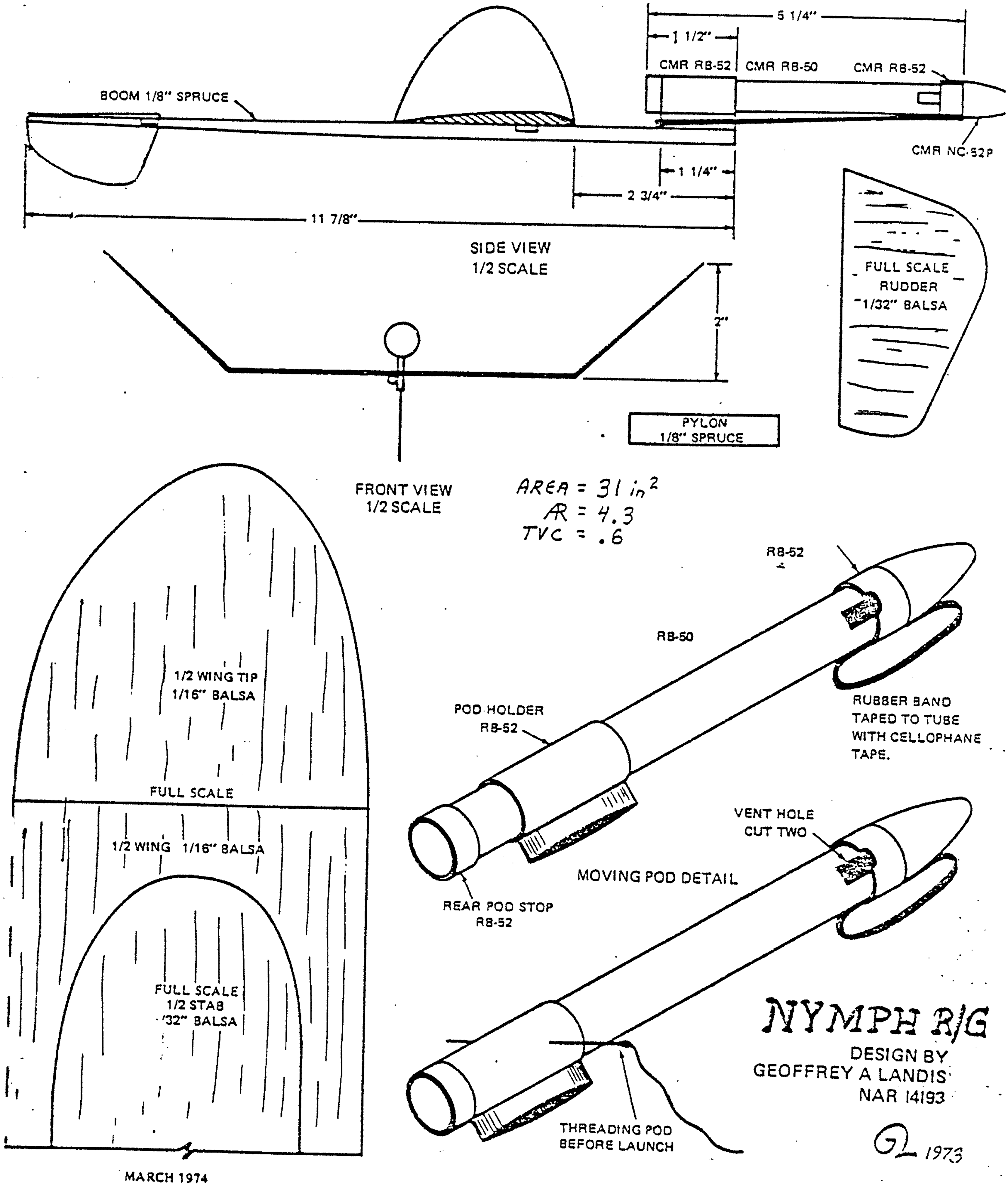
The Nymph flies well in Gnat, Hornet, and Sparrow R/G, but if you build it strong, it'll fly pretty well for Swift, too. I finally destroyed my first Nymph on its 13th flight when I tried to fly it for Hawk R/G at ETR-3. The glider held up—but the engine burned through the casing! If you treat it well, though, it'll probably fly away before it breaks. So try a moving pod R/G . . . you'll find it works.

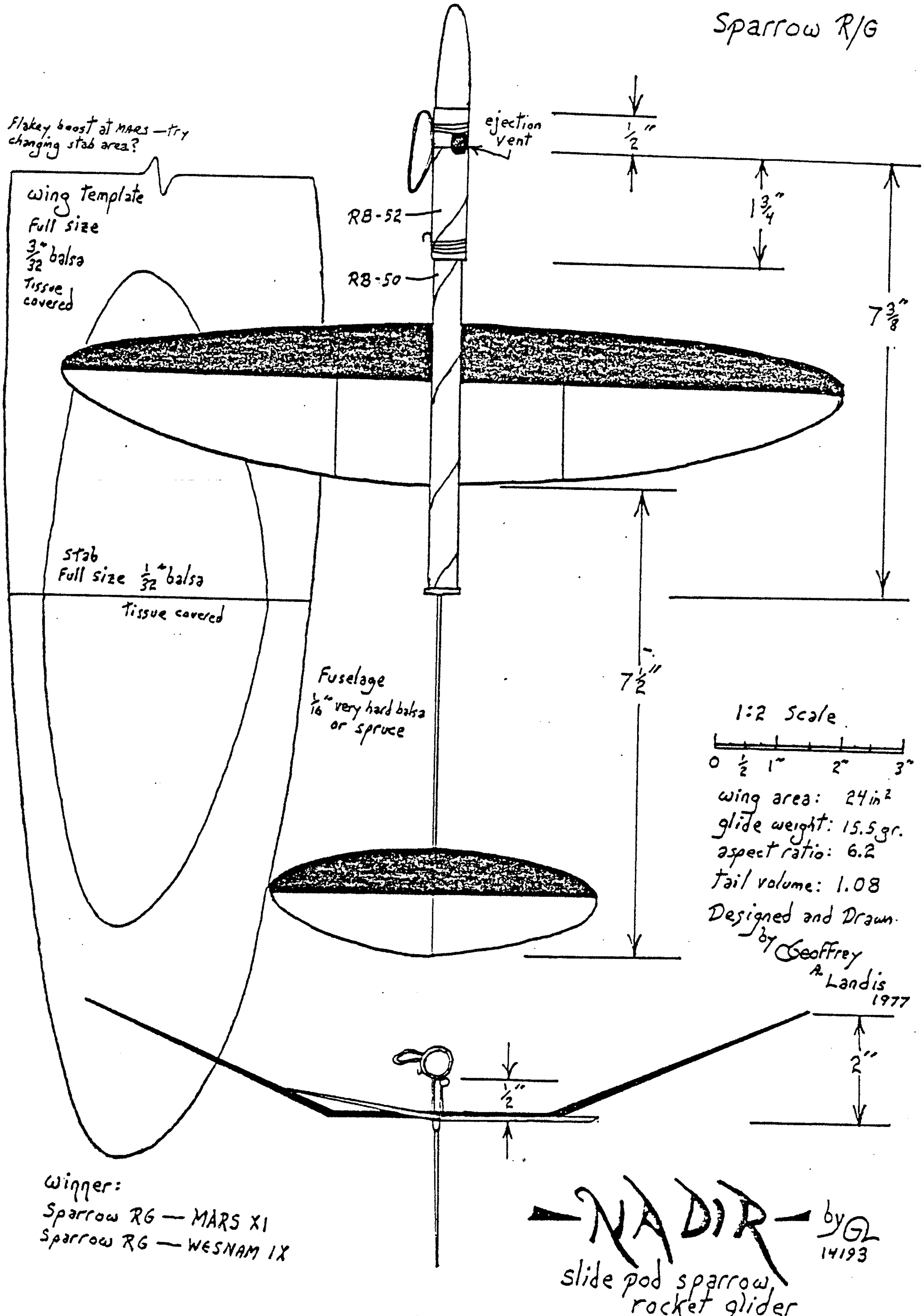




Geoffrey Landis, a model rocketeer since 1966, joined the NAR in 1968. He served as president of the Evanston Model Rocketry Association for two years and founder and president of the New Trier Rocket Association. He is currently a member of the MIT Model Rocket Society. Geoffrey's special interest is in R & D.

Hornet R/G


5 1/4"
1 1/2"
CMR RB-52
CMR RB-50
CMR RB-52
BOOM 1/8" SPRUCE
CMR NC-52P
1 1/4"
2 3/4"
11 7/8"
SIDE VIEW
1/2 SCALE
2"
FULL SCALE
RUDDER
1/32" BALSA
PYLON
1/8" SPRUCE
FRONT VIEW
1/2 SCALE
AREA = 31 in²
AR = 4.3
TVC = .6
RB-52
RB-50
1/2 WING TIP
1/16" BALSA
POD HOLDER
RB-52
RUBBER BAND
TAPED TO TUBE
WITH CELLOPHANE
TAPE.
FULL SCALE
1/2 WING 1/16" BALSA
VENT HOLE
CUT TWO
MOVING POD DETAIL
REAR POD STOP
RB-52
FULL SCALE
1/2 STAB
1/32" BALSA
NYMPH R/G
DESIGN BY
GEOFFREY A LANDIS
NAR 14193
THREADING POD
BEFORE LAUNCH
GL 1973
MARCH 1974


Sparrow R/G
Flakey boost at MARS — try changing stab area?
wing template
Full size
3/32" balsa
Tissue covered
ejection vent
1/2"
1 3/4"
7 3/8"
RB-52
RB-50
stab
Full size 1/32" balsa
Tissue covered
Fuselage
1/16" very hard balsa or spruce
7 1/2"
1:2 Scale
0 1/2 1" 2" 3"
wing area: 24 in²
glide weight: 15.5 gr.
aspect ratio: 6.2
tail volume: 1.08
Designed and Drawn by Geoffrey A. Landis
1977
2"
1/2"
winner:
Sparrow RG — MARS XI
Sparrow RG — WESNAM IX
NADIR
by GL
14193
slide pod sparrow rocket glider

Lumb Duck

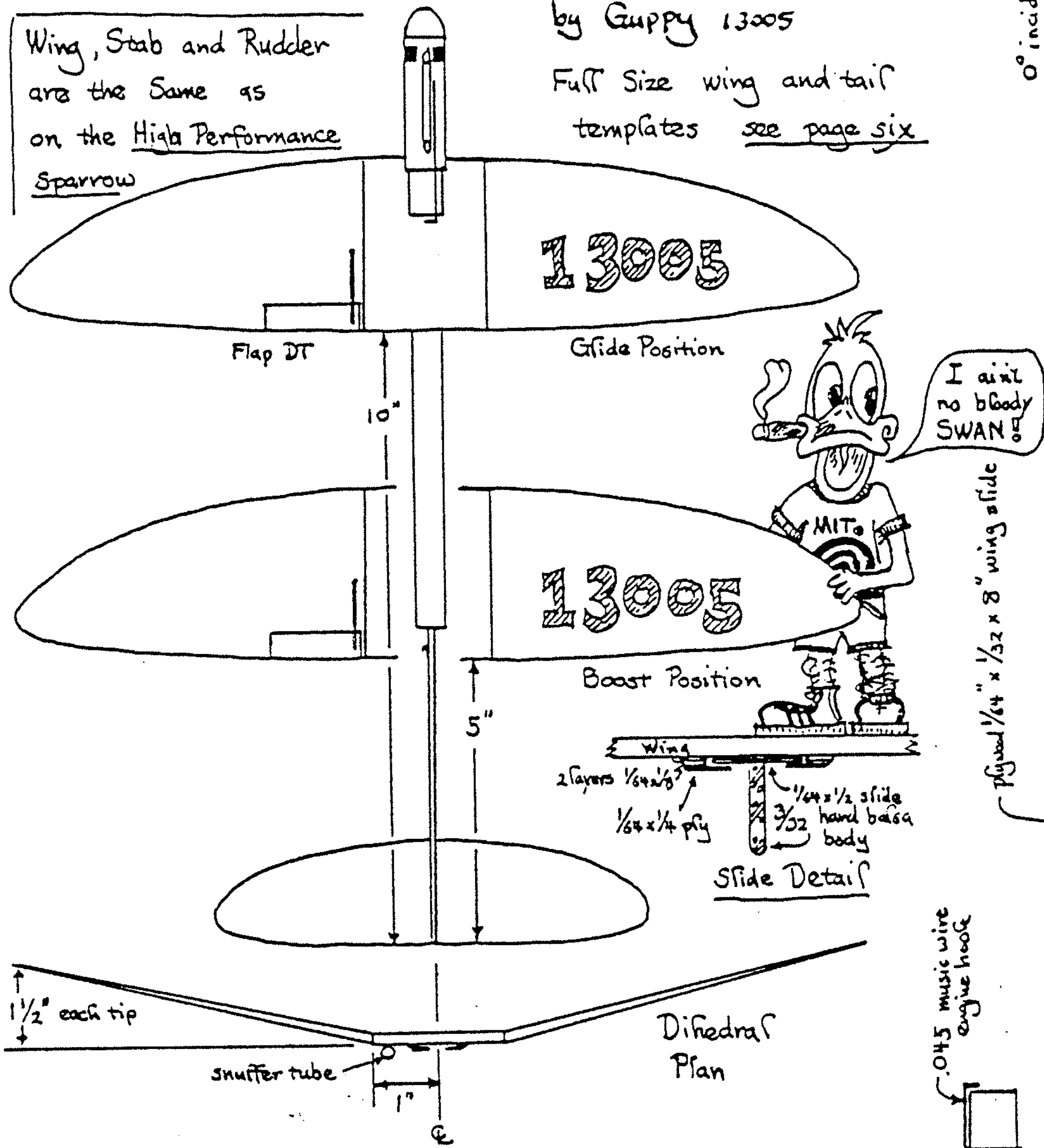
1st place Swift R/G

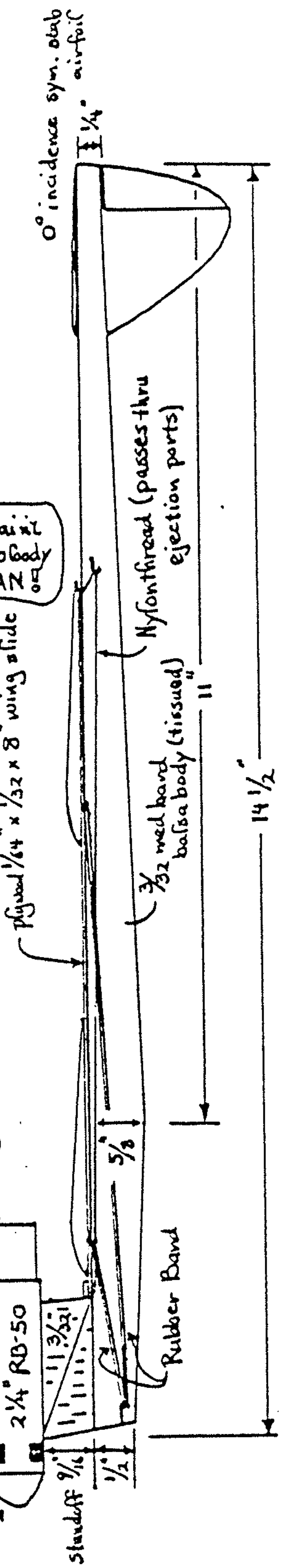
Naram - 18 197 sec.

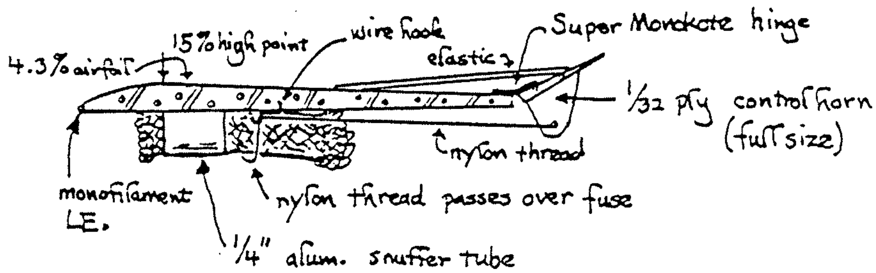
by Guppy 13005

Full Size wing and tail templates see page six

Wing, Stab and Rudder are the Same as on the High Performance Sparrow





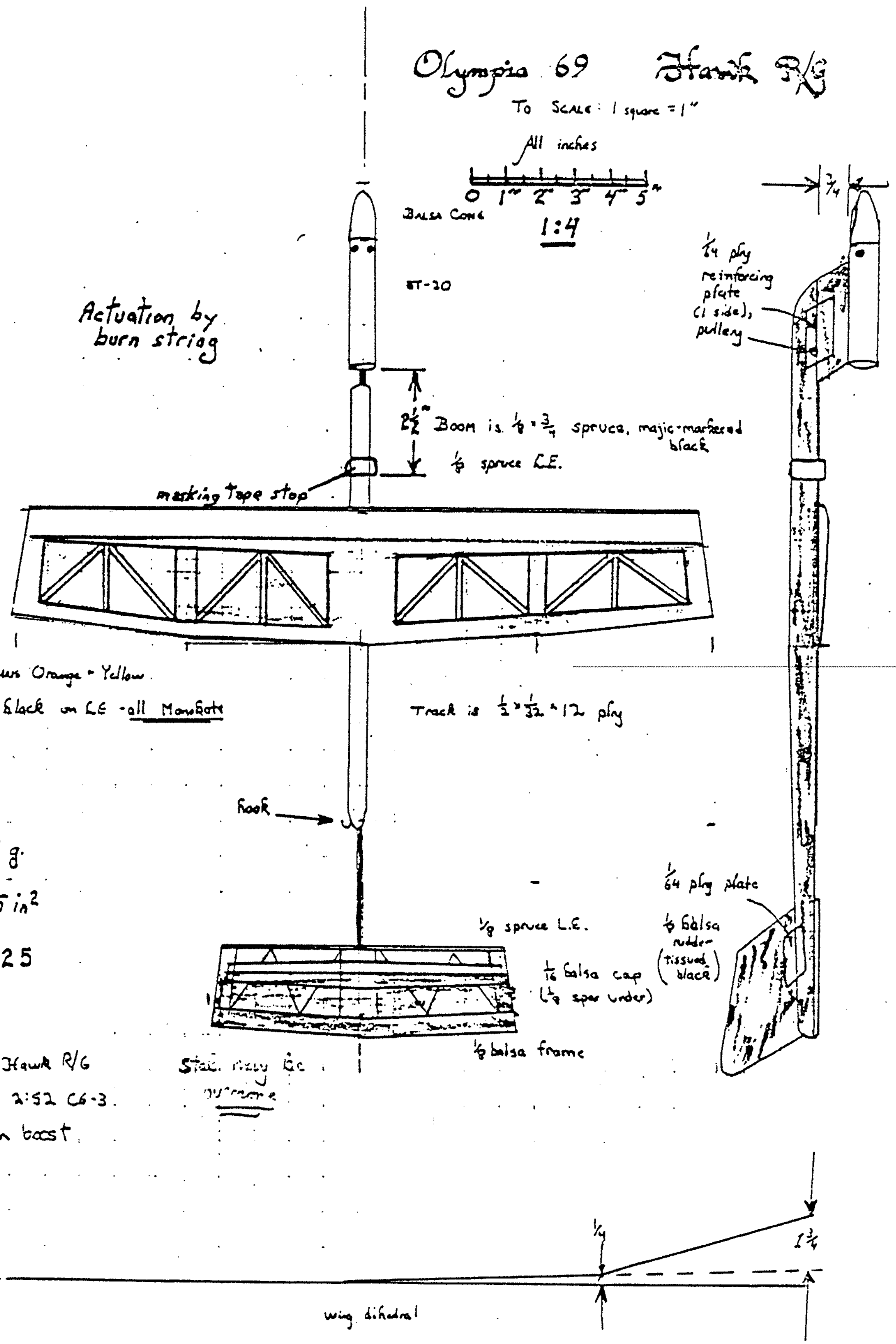


Flap DT Detail

Parts Detail (on original)

Wing	1/8"	5.5 lb/ft³ Balsa	tissued
Stab	1/16"	6.7 lb/ft³ Balsa	tissued
Rudder	1/16"	6.7 lb/ft³ Balsa	tissued
fuselage	3/32"	12.5 lb/ft³ Balsa	tissued

Olympia 69 Hawk R/G



Wing

¼ balsa, 5 lb stock

⅛" T.E. stock

⅛ LE spruce

⅛" Bracing in Wing

Color - Trans Orange + Yellow

surfaces - Black on LE - all MonoKote

Weights

Empty 45 g.

AREA = 75 in²

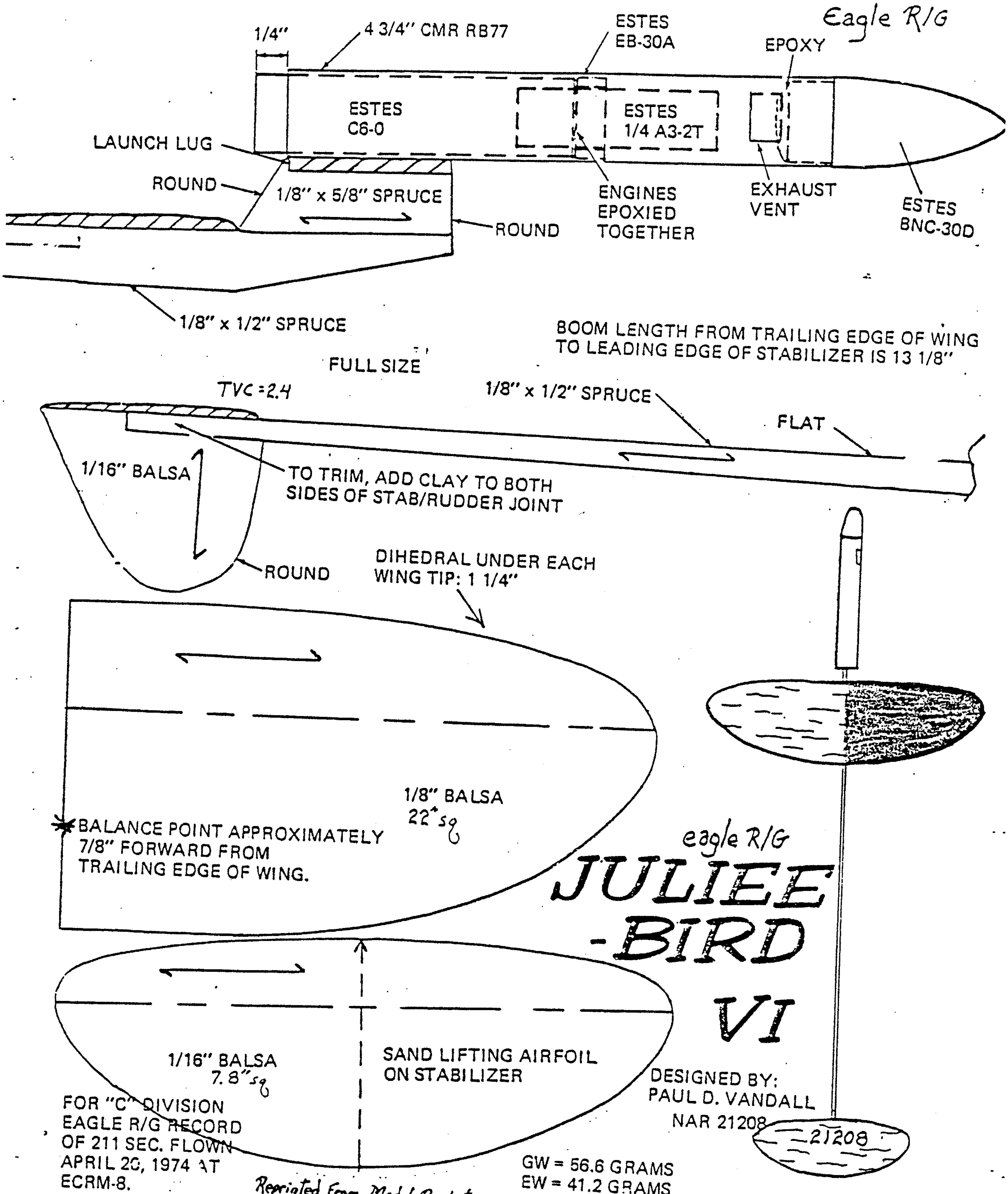
AR = 5

TVC = 1.25

MARS-XI Hawk R/G

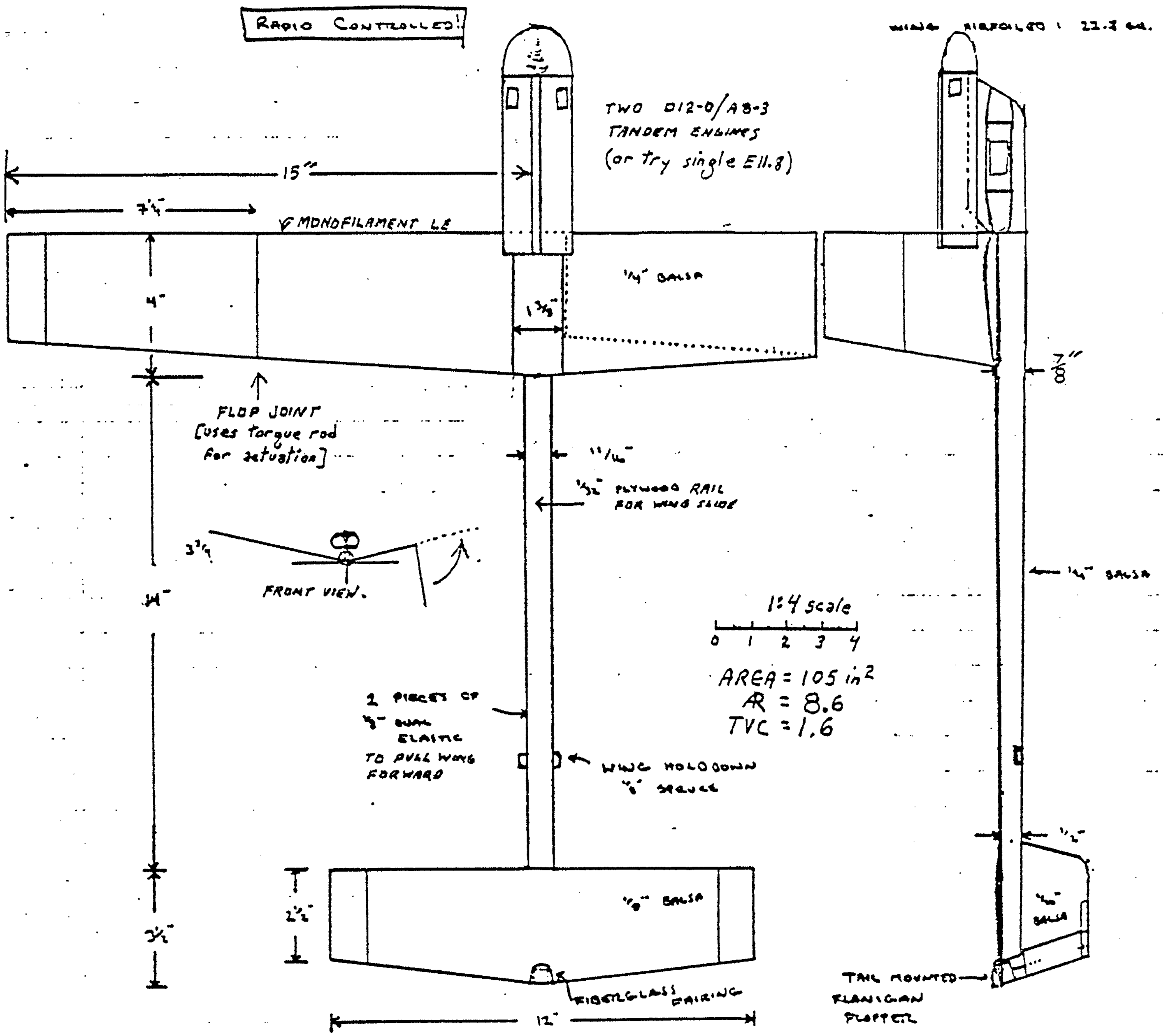
First place 2:52 C6-3

gyrations on boost



Reprinted From *Model Rocketeer* magazine

Subject WESNAM-7 CONDOR R/G



OCT 4, 1975 WESNAM-7

FLOWN WITH D12 AND E5. VERY NICE BOOST, EXCEPT THAT THE STAB BROKE OFF AT ABOUT 100'. WINGS ACTIVATED FINE, EXCELLENT CONTROL ON WAY DOWN, ROLLING RIGHT AND LEFT BEFORE [illegible].

HIG!

Condor Rocket Glider

SLIDING FLOP-WING

by Chris Flanigan 17540

FLYING FROG V ROCKET-GLIDER

by Bernard Biales NAR 6716

In response to Bob Parks' first flop wing R/G in May, 1971, I decided to see if it was possible to adapt my flexwing B/G design to R/G. After discarding a design with an I-beam fuselage, I built a model quite similar to this one. I named the series after a South American gliding amphibian because the flexie B/G's had been named after a flying reptile.

The first tests showed serious reliability problems, but with this version I got all the major problems under control except one. If this type of glider exceeds a certain speed in a dive, the wings flutter and prevent any recovery. In the design shown here, the wings opened on each of its last six flights, but transition occurred only half the time.

When it does work, the Flying Frog boosts fast and high, then settles quickly into a nice slow glide. No conventional R/G has as much performance potential, and the design needs to have a dethermalizer added. At one time, this model held the A engine R/G record in division D and almost picked up the B/G record too.

HINTS: Elastic tension must be very high. You may have to use a different (longer) elastic in cold weather. Position the elastic on the nose hook just before launch and remove it as soon as the model is recovered. Double check all launch preparations. After the flight inspect the front of the pod for ejection charge damage. Use short delay engines (the original held together under boost with a 3½ N-sec mini-B).

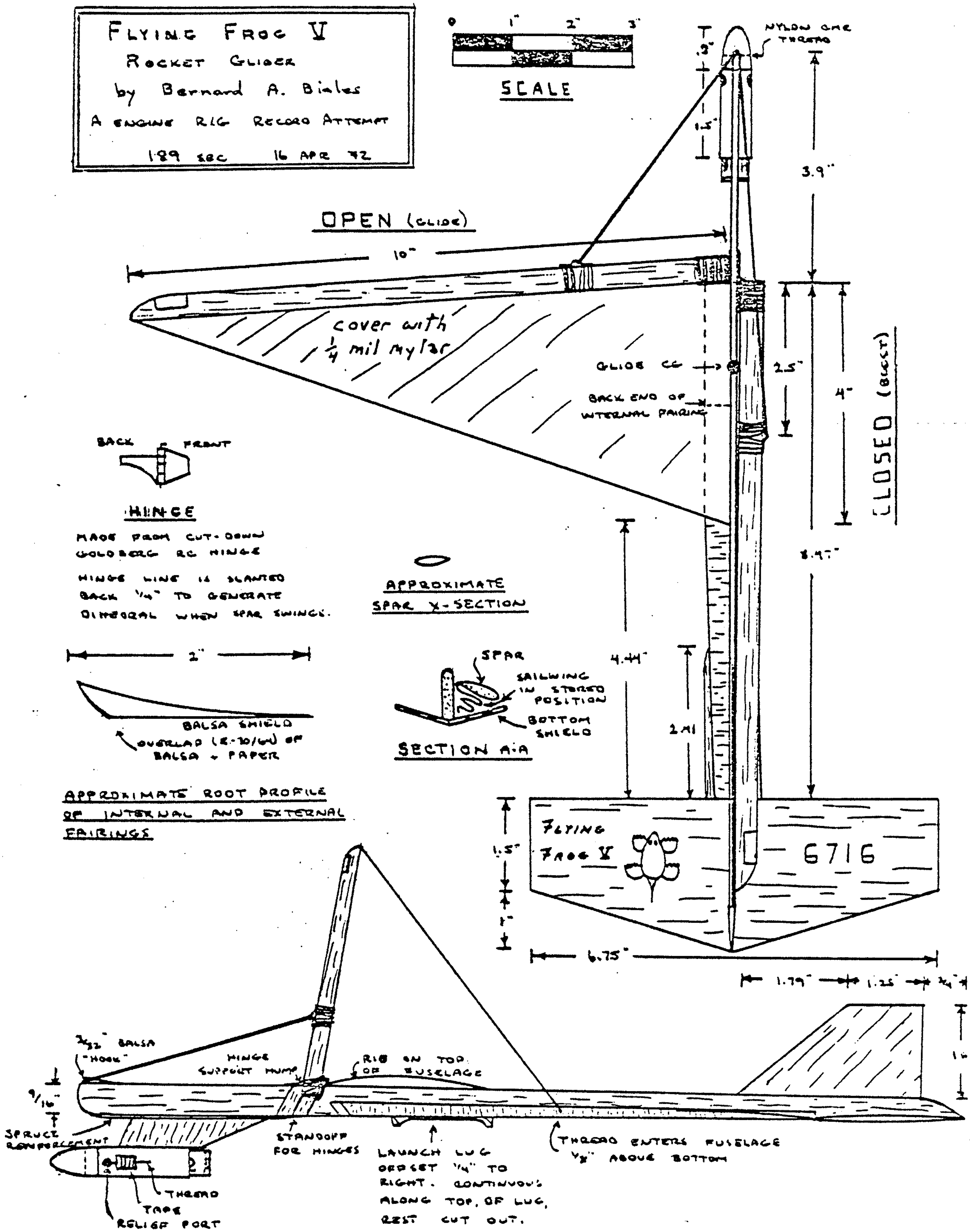
MATERIALS AND DIMENSIONS

1) POD - Nose Cone: Estes 651-BNC-5V, .52" diameter (.8" long plus ¼" shoulder) moderately hollowed. Boundary layer trip - CMR nylon thread. Tube: peeled BT-5 .52" x 1.51". Pylon: 1/16" balsa, .45" high, leading edge swept forward ¼", trailing edge swept 3/4", root chord 2.19", tip chord 1.59". Engine (mini-brute) protrudes 3/16".
2) FUSELAGE - Basic piece: 3/32" x .55" x 14.92" balsa. Chin reinforcement piece: 3/32" x 1/16" x 3.61" spruce. Bottom shields: 1/16" x (1" max, 19/32" min) x 8.55" balsa. Extra fairings near tail also 1/16" balsa, 2.41" long. Hinge stand-offs: 1/32" balsa. Elastic retainer; Hinge support hump; and central rib also balsa. Internal and external fairings at front of bottom shield: Estes heaby paper (sold for conical fairings) Launch lug: 3/16" OD x 1 5/8".
3) WINGS - Wing spar: 10" length, 13/32" x .1" @ root, 5/16" x .07" near tip; balsa. Hinge: nylon, retained by thread and epoxy. Circular wire retainer for elastic thread: .015" piano wire, held by epoxy and thread. Wing trailing edge: CMR nylon thread epoxied on and paper retainers at wing tips. Covering material: 1/4 mil aluminized mylar. Fairings at spar roots of Estes heavy paper. Wing opened by 4 strand elastic thread - total length relaxed approx. 19".

4) HORIZONTAL STABILIZER - balsa, .09" thick at root, .06" thick at tip. Tissue covered.
5) FIN - 1/16" balsa, tissue covered.
6) CENTRAL RIB -1/16" thick, 2 5/16" long, 15/64" max. depth.

During boost the wings are held shut by CMR nylon thread tied to the right wire loop, passing across the top of the fuselage and wing spars and through the left loop, in the right pod port, and out the left port, then taped to body tube.

REPRINTED FROM THE JOURNAL
OF THE MIT ROCKET SOCIETY
january 1975 issue



Flying Frog V
Rocket Glider
by Bernard A. Biales
A engine R/G Record Attempt
189 sec 16 Apr 72
0 1" 2" 3"
SCALE
NYLON ONE THREAD
.3"
1.5"
3.9"
OPEN (glide)
10"
cover with 1/4 mil mylar
GLIDE CG
BACK END OF INTERNAL FAIRING
2.5"
4"
CLOSED (boost)
8.47"
BACK FRONT
HINGE
MADE FROM CUT-DOWN GOLDBERG RC HINGE
HINGE LINE IS SLANTED BACK 1/4" TO GENERATE DIHEDRAL WHEN SPAR SWINGS.
APPROXIMATE SPAR X-SECTION
2"
BALSA SHIELD
OVERLAP (2-3/64) OF BALSA + PAPER
SPAR
SAILWING IN STORED POSITION
BOTTOM SHIELD
SECTION A-A
4.44"
2.41
APPROXIMATE ROOT PROFILE OF INTERNAL AND EXTERNAL FAIRINGS
Flying Frog V
6716
1.5"
1"
6.75"
1.79"
1.25"
1/32" BALSA "HOOK"
HINGE SUPPORT HUMP
RIB ON TOP OF FUSELAGE
9/16"
SPRUCE REINFORCEMENT
STANDOFF FOR HINGES
LAUNCH LUG OFFSET 1/4" TO RIGHT. CONTINUOUS ALONG TOP OF LUG, REST CUT OUT.
THREAD ENTERS FUSELAGE 1/8" ABOVE BOTTOM
THREAD
TAPE
RELIEF PORT

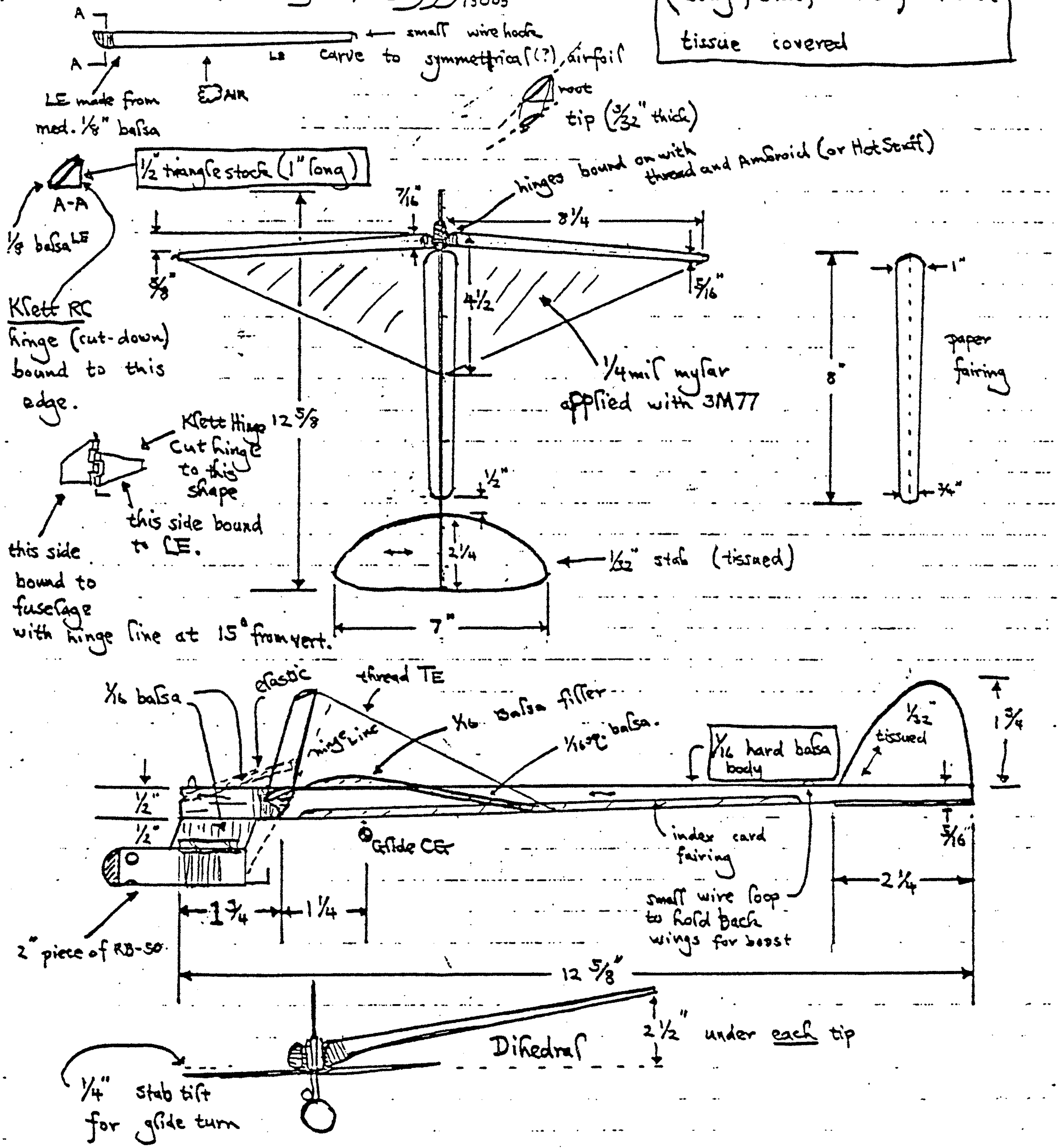
Gnat Flexwing

won 1st at Mars-40

Subject **Flex · Wing**

design by Guppy 13005

(body, Stab, rudder) must be tissue covered



Some Competition Considerations for Altitude Events

by John Langford
NAR 13672

In the spectrum of NAR competition events, those stressing altitude perfomance seem to have gone out of style. Popular in the early days of the hobby, tracking events with their tedious tracking procedures have been overshadowed by the more glamorous events such as boost glide or scale. Tests have shown that engine impulse is perhaps the most importannt variable in altitude optimization, reducing tracking events to games of chance made even more risky by tracking loss and error.

Altitude should not be writen off quite so easily. "How high does it go?" is still a natural question of any newcomer, and "mine can go higher than yours" is still a valid challenge. Although strategy seems simple at first glance, altitude evemns feature some subtl complexities which, when considered, make these events into worthy challenges.

Let me define the events of which we speak. Altitude, Payload, and Eggloft are the core altitude events, with Super-roc, Scale Altitude, and Design Efficiency on the perimeters adding color. Of course, altitude is a central goal in Parachute Duration and Streamer Duration, and....suddenly that obscure event of altitude has become crucial to almost evey event. Concepts such as drag reduction are well-discussed in rocketry circles, and various launching devices have been under development for years. This article will merely make a few points that may be worth considering, and might otherwise be overlooked because of their seeming simplicity

The first, and most important consideration in an altitude oriented event is to get the model off the launcher on a straight up trajectory. No amount of impulse, performance, or velocuty will help a launch that is not straight. Winning flights will almost all have this point in common, and from the looks of many of today's contraption launchers, competitors may be overlooking this obvious fact. If the lauch is not straight, the flight will not be competitive--and the launch must be reliably, cosistantly straight--it must happen evey single flight to be good. This must be the <u>primary</u> launch consideration; all others are secondary. In this respect, good old launch rods rate very highly, and the Biedron-Langford team has gone in many cases to fixed launch luglets. 3/16" diameter rods are highly recommended, especially for heavier models such as dual egglofters or plastic models. For large Scale models or long Superrocs a C-Rail is probably the best. All of these rods can be used with a pop-lug so they they don't necessarily mean an increase in a model's drag, and the larger rod pays off when the model is heavy or long. Long rods are an asset for gliders, too. Guppy has graphic computers simulations showing the effect of rod length on boost-glide trajectory, and the results with longer rods are impressive.

Drag minimization is an important point, but it has been so well covered that it will be virtually ignored here, except to say that the better the finssh the better the performace; for more see Jeff Flygare's Drag article, or Estes TR-11 by Dr. Gregorek. Many methods have been devised for elimination the launch lug on altitude models; again, I will not try to discuss the merits of such systems except to say that the piston launcher looks best at this point. My point is that however you launch, it is worthless if it is not straight.

Flight path is another thing to consider. The trackers must be able to see your model, so paint it black or florescent. Smokeless engines are no fun for trackers, and slow-moving models are easier to follow. Before flying, always look over the tracking setup. Note where the trackers are in relation to the launcher and to the sun. Since the geometry of low-

AZIMUTH DATA REDUCTION IS NOT COMPATABLE WITH THE STANDARD NAR TABLES, TRACKS MADE OVER THE BASELINE WILL ALMOST NEVER CLOSE. IF YOU USE THE SPECIAL EQUATIONS FOR LOW AZIMUTH REDUCTIONS (TOM MILKIE IN 1975 JOURNAL) YOU CAN GET MOST TO CLOSE, BUT YOU WILL HAVE TO SEE THAT THIS IS DONE YOURSELF, AS NO CONTEST OFFFICIAL WILL POINT IT OUT. THE SAFEST IDEA IS NOT TO FLY OVER THE BASELINE.

SUN POSITION IS A CRUCIAL FACTOR. UNDER NO CONDITUONS DO YOU WANT TO PUT YOUR MODEL BETWEEN A TRACKER AND THE SUN, AS THIS IS A SURE "TRACK LOST". A GOOD FLYING FIELD WILL BE SET UP SO THAT THE SUN AND THE BASELINE ARE ON THE SAME SIDE OF THE FIELD (AND, IDEALLY, DOWNWIND) BUT SUCH IS NOT ALWAYS POSSIBLE. THE SUN, OBVIOUSLY, MOVES DURING THE DAY, SO THAT A TRACKING NET IDEAL FOR MORNING FLYING MAY BECOME INTOLERABLE IN THE AFTERNOON (THIS WAS THE CASE AT NARAM-18).

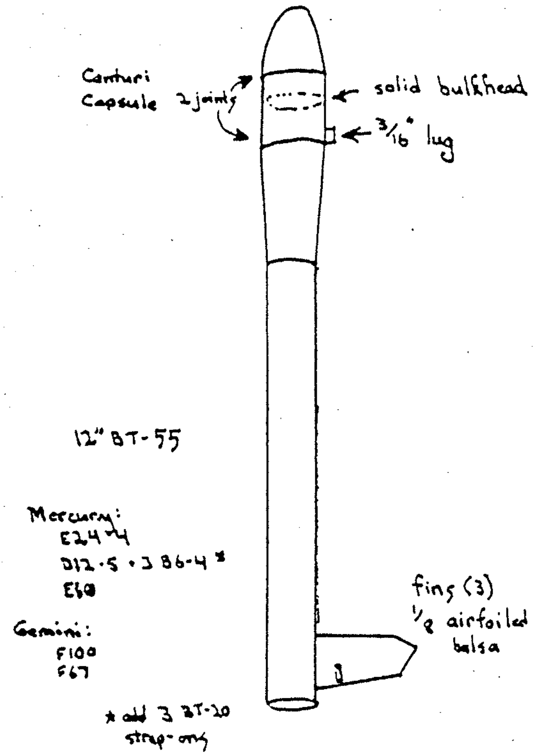
WIND AND WEATHERCOCKING ARE CONSIDERATIONS, TOO. HARRY STINE IN HIS HANDBOOK TALKS ABOUT POINTING A MODEL SLIGHTLY WITH THE WIND SO THAT WHEN IT WEATHERCOCKS IT WILL STILL BE GOING STRAIGHT UP. THIS IS A USEFUL TECHNIQUE, BUT ITS EFFECTIVENESS VARIES FROM MODEL TO MODEL AND DEPEND PARTIALLY ON THE TYPE OF LAUNCHER YOU ARE USING. KNOWING YOUR MODEL IS THE ONLY PRACTICAL EAY OF APPLYING THE SYSTEM, AND THAT MEANS TEST FLYING.

ONCE A MODEL UP IT MUST BE TRACKED AT ONE POINT. IF THE TRACKERS DO NOT BOTH SIGHT ON THE MODELAT THE SAME INSTANT THE TRACK WILL NOT CLOSE. TRACKERS USED TO FOLLOW MODELS TO APOGEE AND "MARK" THERE, BUT APOGEE IS OFTEN INVISIBLE, ESPECIALLY AGAINST A WHITE CLOUD SKY WHEN THE SMOKE TRAIL IS NOT VISIBLE. THE PERCENTAGE OF CLOSED TRACKS HAS INCREASED SINCE THE COMMON INTRODUCTION OF TRACKING POWDER EJECTED AT PARACHUTE DEPLOYMENT, WHICH IS THE COMMON "MARK" USED IN TRACKING TODAY. THE PROBLEM BECOMES, HOWEVER, THAT IT NO LONGER REALLY MATTERS HOW HIGH YOUR MODEL REALLY GOES, BUT ONLY HOW HIGH IT DEPLOYES ITS RECOVERY DEVICE. DELAY TRAIN OPTIMIZATION IS A VERY UNEXPLORED AREA. THE BEST ONE CAN DO IS USE THE ESTES OR CENTURI PREDICTION CHARTS, GUESSTIMATE AN OPTIMUM DELAY, AND TRY AND MATCH THAT WITH A COMMERCIAL ENGINE. IT SEEMS SAFER TO GO WITH A LONGER DELAY THAT A SHORTER-THAN-OPTIMUM ONE, FOR IF THE APOGEE IS CLEARLY VISIBLE AND THE TRACKERS AHVE GOOD COMMUNICATIONS, THEY MAY CHOOSE TO TRACK THE APOGEE RATHER THAN THE DEPLOYMENT. (MANY TRACK LOSTS MAY RESULT IF THE TRACKERS ATTEMPT TO MAKE SUCH A DECISION INDEPEDENTLY OF EACH OTHER).

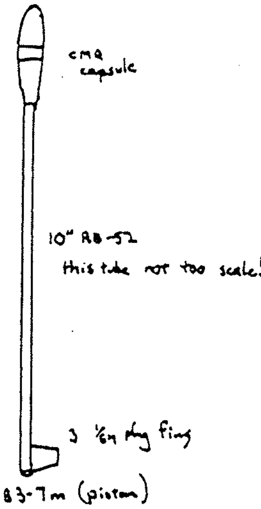
LOOKING AT THE ALTITUDE PREDICTION CHARTS CAN POINT OUT ANOTHER USEFUL THING: THE CONCEPT OF OPTIMUM WEIGHT. FOR A GIVEN IMPULSE, ALMOST REGARDLESS OF DRAG COEFFICIENT, THERE IS A WEIGHT THAT WILL MAXIMIZE THE ALTIUDE. THE MODEL WEIGHT SHOULD BE AS CLOSE AS POSSIBLE TO THIS OPTIMUM. IN THE DAYS BEFORE MINI-ENGINES THIS CONSDIERATION WASN'T NECESSARY SINCE THE ENGINE WEIGHT ALONE USUALLY EXCEEDED THE OPTIMUM, AND THE ONLY CONSIDERATION WAS MINIMIZING WEIGHT. THE INTRODUCTION OF VERY SMALL AND VERY LARGE ENGINES HAS PUT MODELERS INTO THE INTERESTING POSITION OF ACTUALLY ADDING WEIGHT TO SOME MODELS. THIS CAN BE DONE WITH TRACKING POWDER OR LEAD, BUT REMEMBER TO PUT THE WEIGHT UP FRONT.

THIS BRIEF ARTICLE HAS OVERLOOKED MANY FACTORS, INCLUDING IMPULSE SELECTION, OPTIMUM THRUST-TIME PROFILE, SPECIAL LAUNCHERS, FINSIH CONSIDERATIONS, AND THE LIKE. IT HAS HOPEFULLY BROUGHT ATTENTION TO THE IMPORTANT ROLES PLAY BY HTREE CONSIDERATIONS THAT ARE OFTEN OVERLOOKED, NAMELY, THE PREDOMINANT IMPORTANCE OF A STRAIGHT LAUNCH, TRAJECTORY PLACEMENT, AND DELAY TRAIN CONSIDERATION. WHEN YOU START LOOKING AT IT, ALTITUDE DOESN'T SEEM SO SIMPLE AFTER ALL!

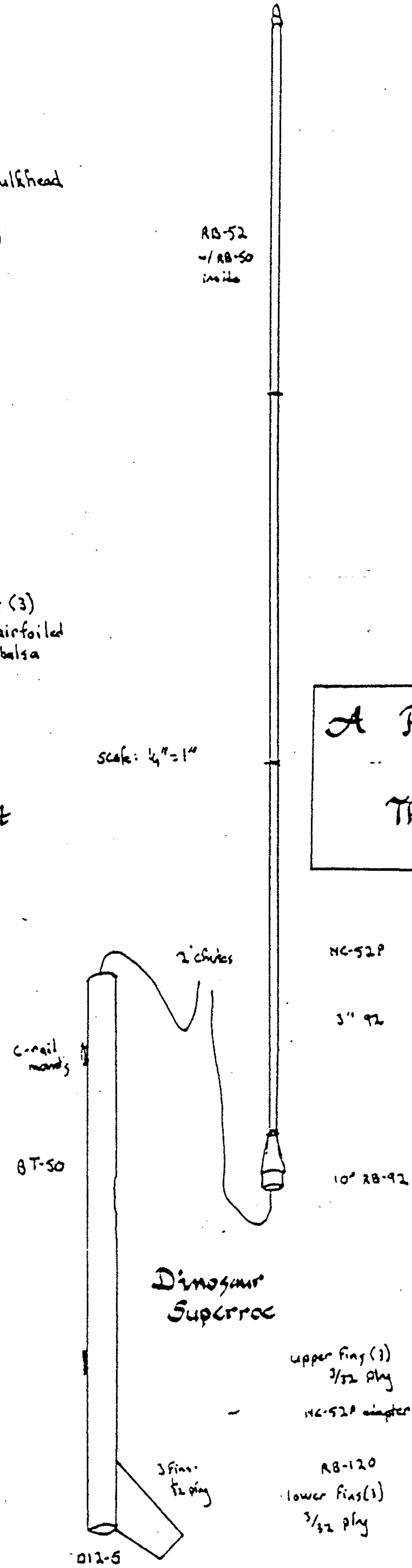
A Potpourri of Altitude Models
stolen from the notebooks of
The Biedron-Langford Team
March, 1977



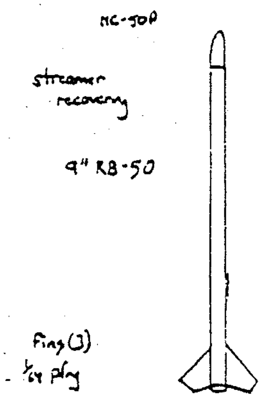
Mercury Dual Eggloft



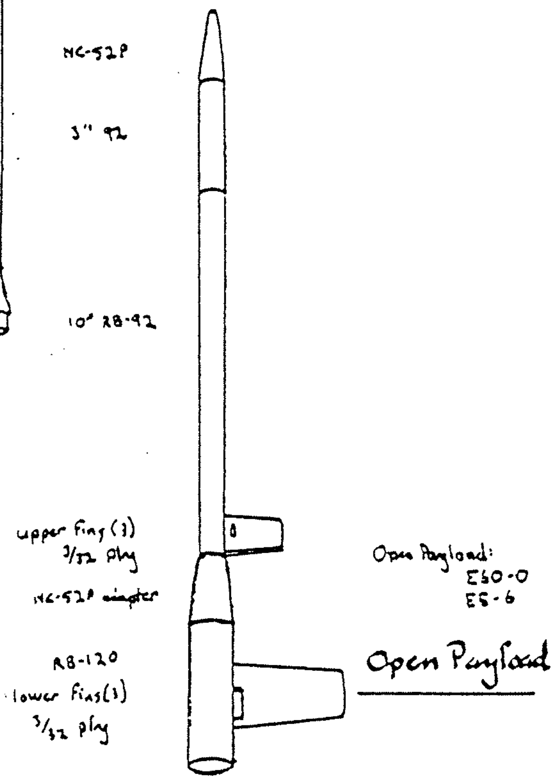
PeeWee Payload



Dinosaur Supercroc



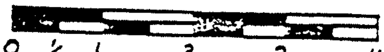
Cl. 2 Altitude



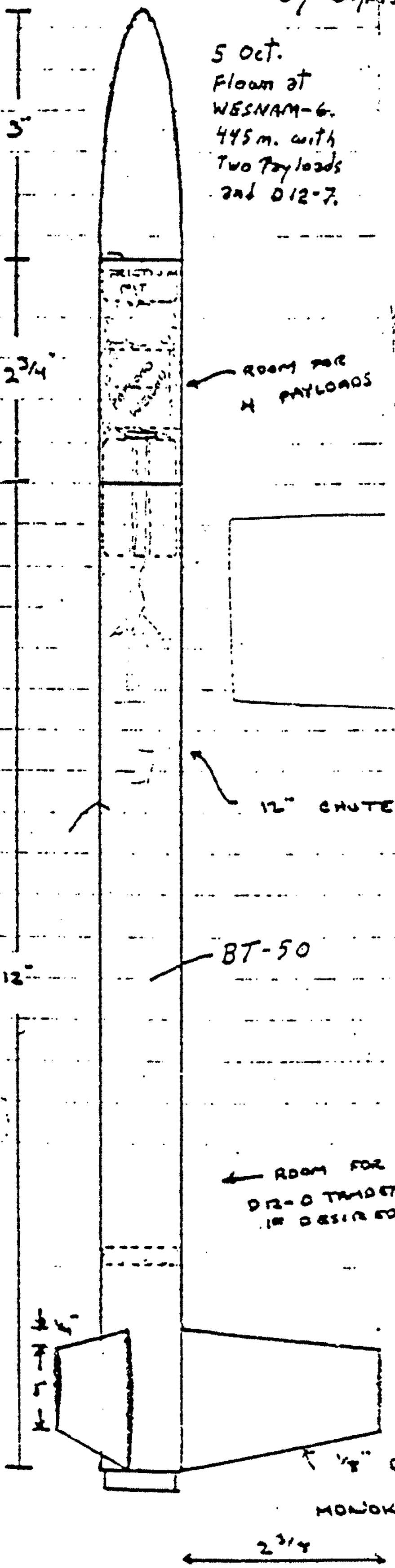
Open Payload

Three Altitude Rockets

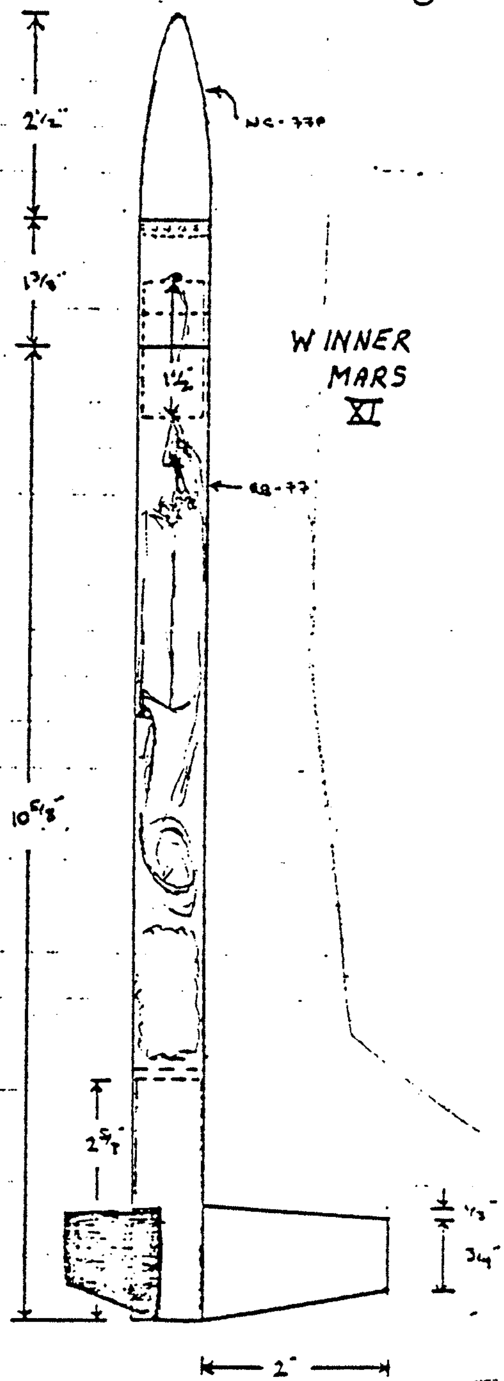
1:2 scale



DUAL PAYLOADER
by Chris Flanigan

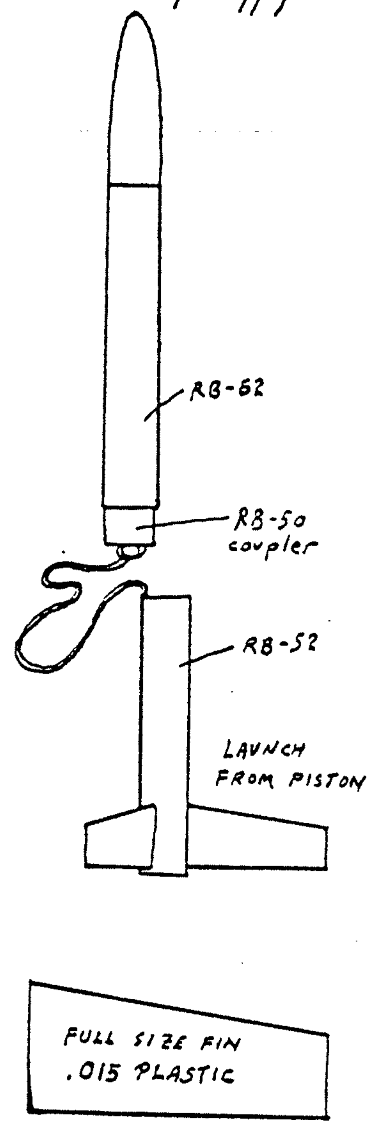


QUADRATHON
by Chris Flanigan



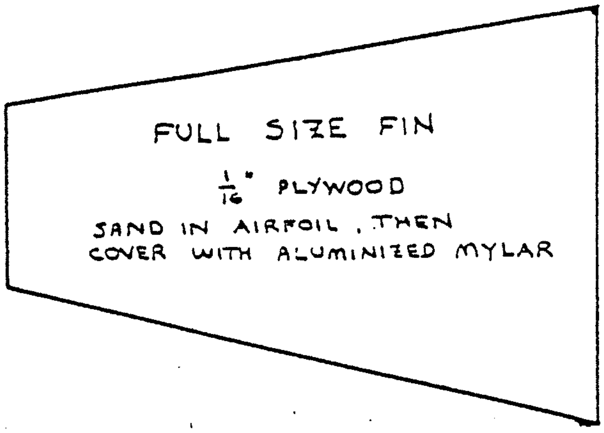
WINNER MARS XI

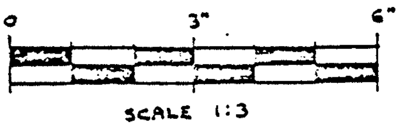
DESIGN EFFICIENCY
by Guppy

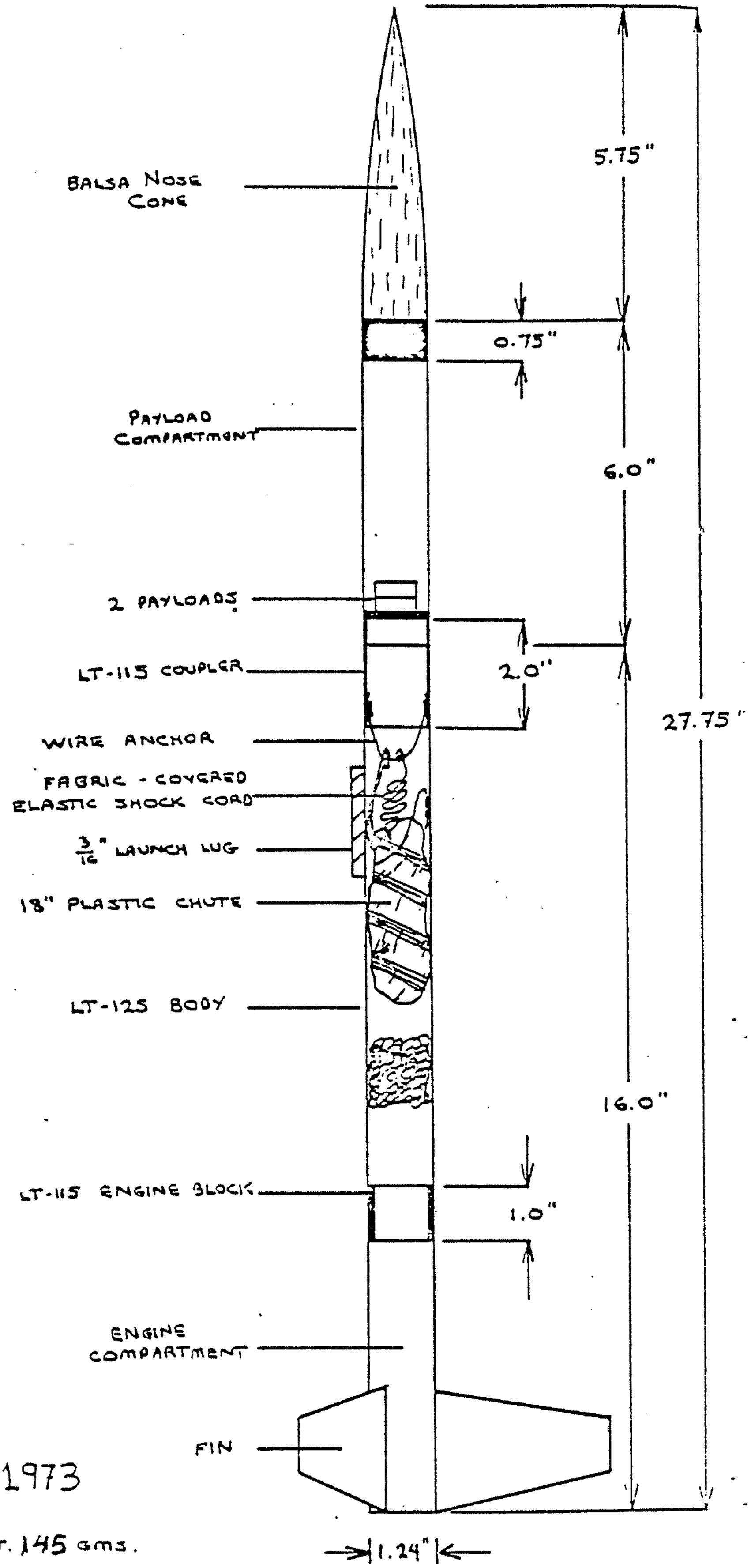


DESIGN EFFICIENCY FIRST PLACE AARDVARK V
178.4 meters/nt-sec.

Open Payload







U.S. OPEN PAYLOADER

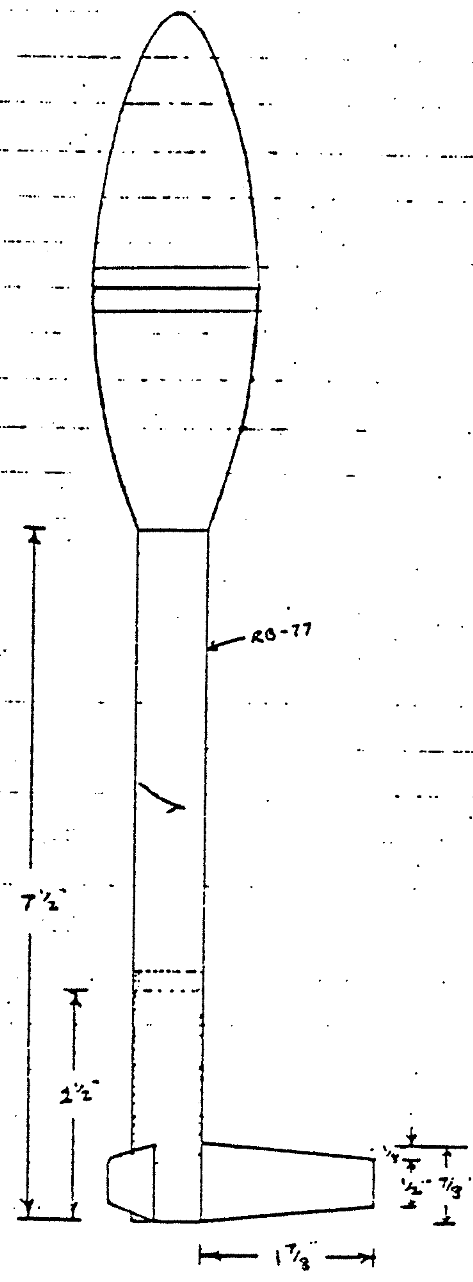
BARBER TEAM - T151 D

532 METERS - 11 JUNE 1973

LIFTOFF WT. 250 GMS., NO-ENGINE WT. 145 GMS.

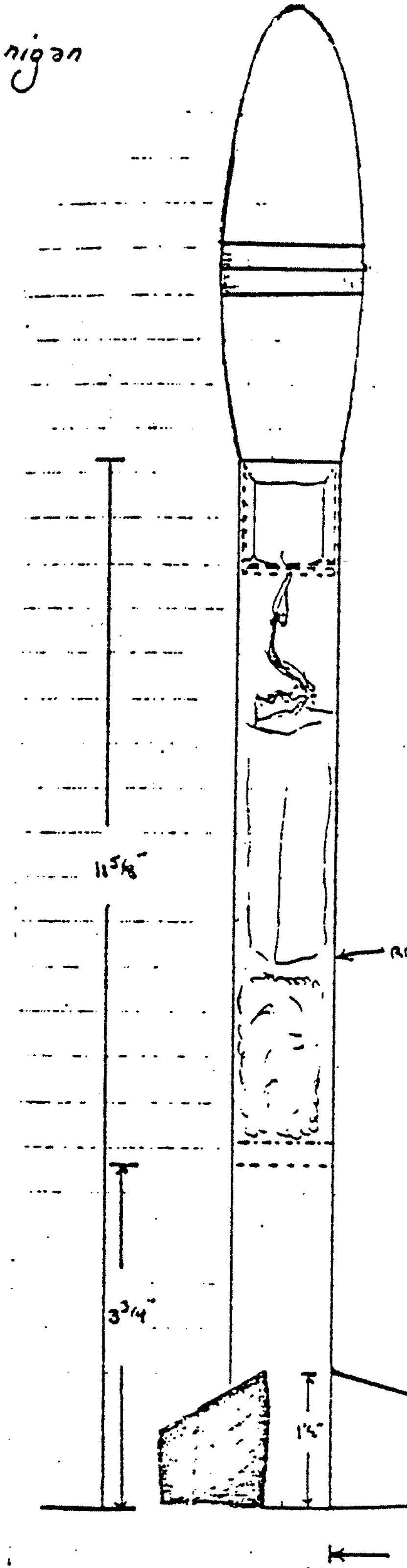
Single Eggloft

designs by Christopher C. Flanigan
17540



FLOWN OFF PISTON AT
NARAM. 205 m for E==.

Robin Egglofter



FLOWN AT MARS-10
WITH D12-36
WORKED WELL,
GOT TRACKED AT
411 m, but MISSED
CLOSING BY ±1 m!

Ostrich Egglofter

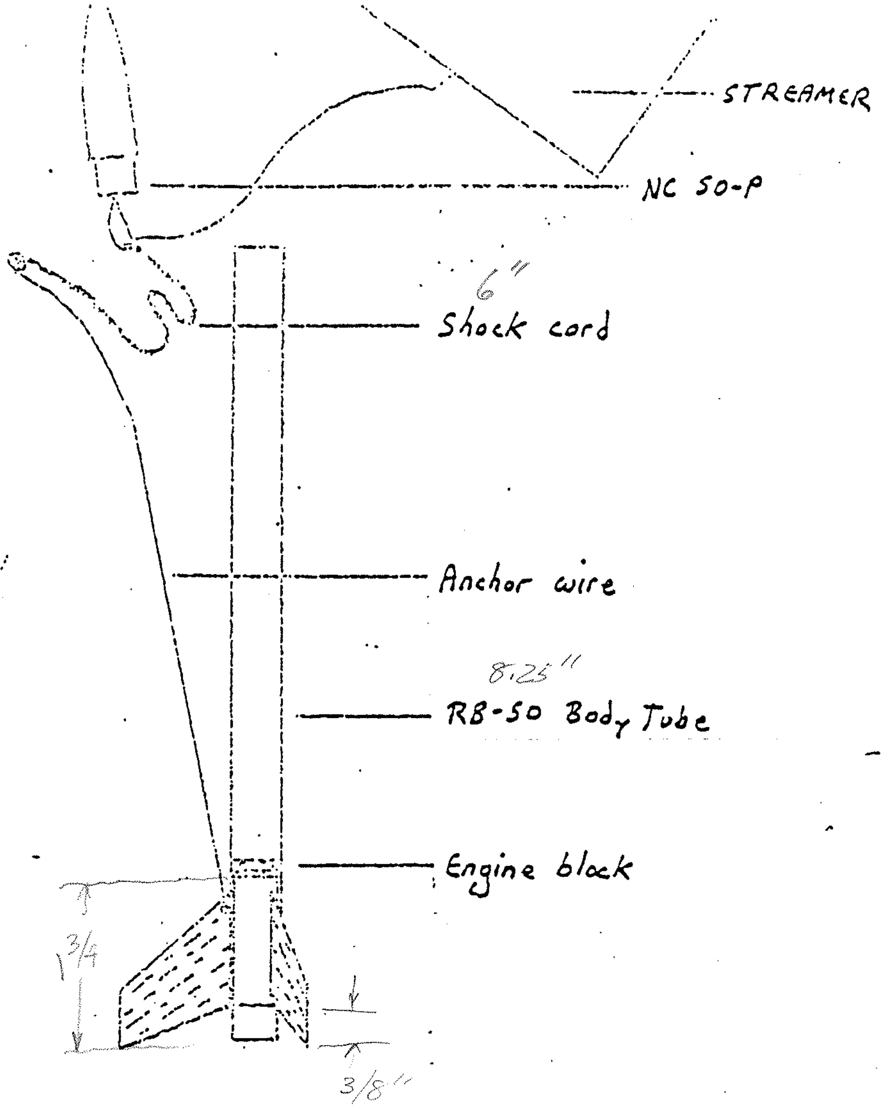
A STREAMER DURATION WINNER

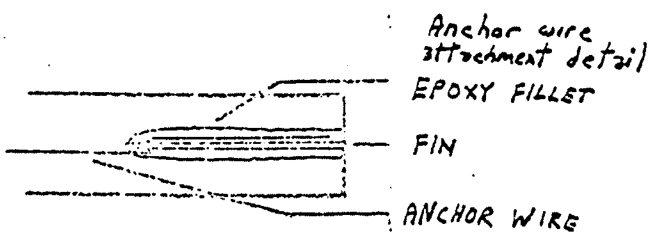
by Trip Barber

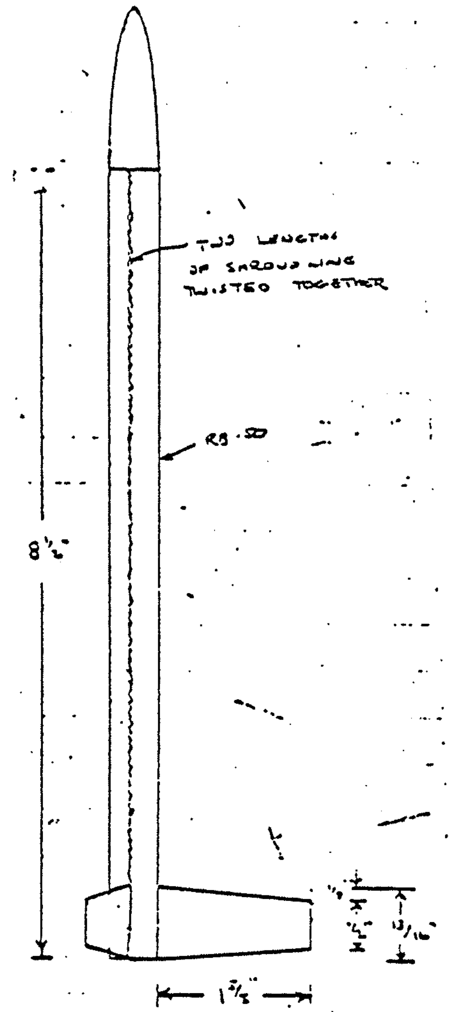
The design on the following page is a high-performance model for Classes 0, 1, and 2 Streamer Duration. It took first place in Class 1 SD at NARAM-17 with a duration of 82 seconds. The design and its construction are quite simple; the key elements are the thin plywood fins, the external shock cord anchor, the choice of streamer material, and the use of a zero-volume piston for launching. All of the parts except the control line, the elastic cord, and the streameer are available from Competition Model Rockets.

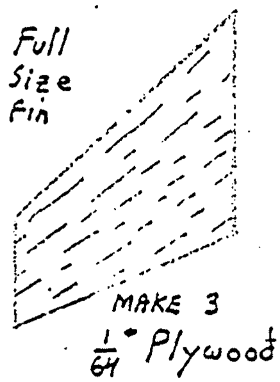
To assemble the model, start with an 8.25" piece of RB-50 body tube. Sand it smooth with very fine grit sandpaper or Flex-i-Grit, using a finishing machine if available. Cover with one coat of thinned clear dope (preferably Sig Litecoat) and allow to dry thoroughly, then repeat the sanding. Cut three fins from an unwarped sheet of 1/64" plywood and sand the leading and outer edges round and the trailing edges tapered. If the fins are warped, press them flat under some books for a day or two. Sand the whole fin smooth with very fine sandpaper, then fill with one coat of thinned Hobbypoxy Stuff and repeat the sanding. Square off the root edge with a sanding block and attach the fins to the body tube with a little Ambroid or Titebond glue. Ensure that they are straight (this is essential for winning performance), then mount the shock cord anchor wire (a 9.5" length of .008" steel model airplane control line) to one fin root as shown in the drawing, and fillet all fins with epoxy. Make a loop in the free end of this wire and attach a 6" length of cloth-jacketed, small-diameter round elastic cord as the shock cord. This material (available in sewing stores) is superior to conventional shock cord in strength and weight. For flight, ensure that the anchor wire is pulled tightly against the body tube to minimize its drag. Add the nose cone and engine block to the model, positioning the latter so that about 3/8" of casing for whichever engine is to be used protrudes from the model for use with the ZVPL launcher. Apply one coat of bright-colored spray dope, then sand the whole rocket smooth.

Flying the model, while also simple, requires very careful attention to ensure maximum performance. Consult the MITRS engine data table for the best engine choice, remembering that if performance factors are equal the best choice is the engine with the least after-burnout weight. Research by Malecki, et al, (NAR Tech Review vol. 2, no. 1) has proved that a ZVPL launch device greatly improves performance; if a ZVPL is not available, at least use a pop launch lug. Research by the author (Model Rocketeer, Sept. 1973) has shown that crepe paper is far superior to mylar or plastic as a streamer material; the recommended streamer for this model for all power classes is 4x40" black (for visibility) crepe. This will fit easily into the body if rolled tightly. Never use a crepe streamer more than twice in a contest model (once on humid days) - the rolling and stretching reduce its drag. Another good streamer material to use is tissue paper, if it can be found in long rolls instead of sheets. A 4.5" by 12-foot tissue streamer will fit easily if rolled around a thin dowel (which is then removed). This streamer will deliver the same performance as a 4x40" crepe on calm days, and will beat it on windy days.









Class 1 SD

NARAM 17, First place

Trip Barber
NAR 4322

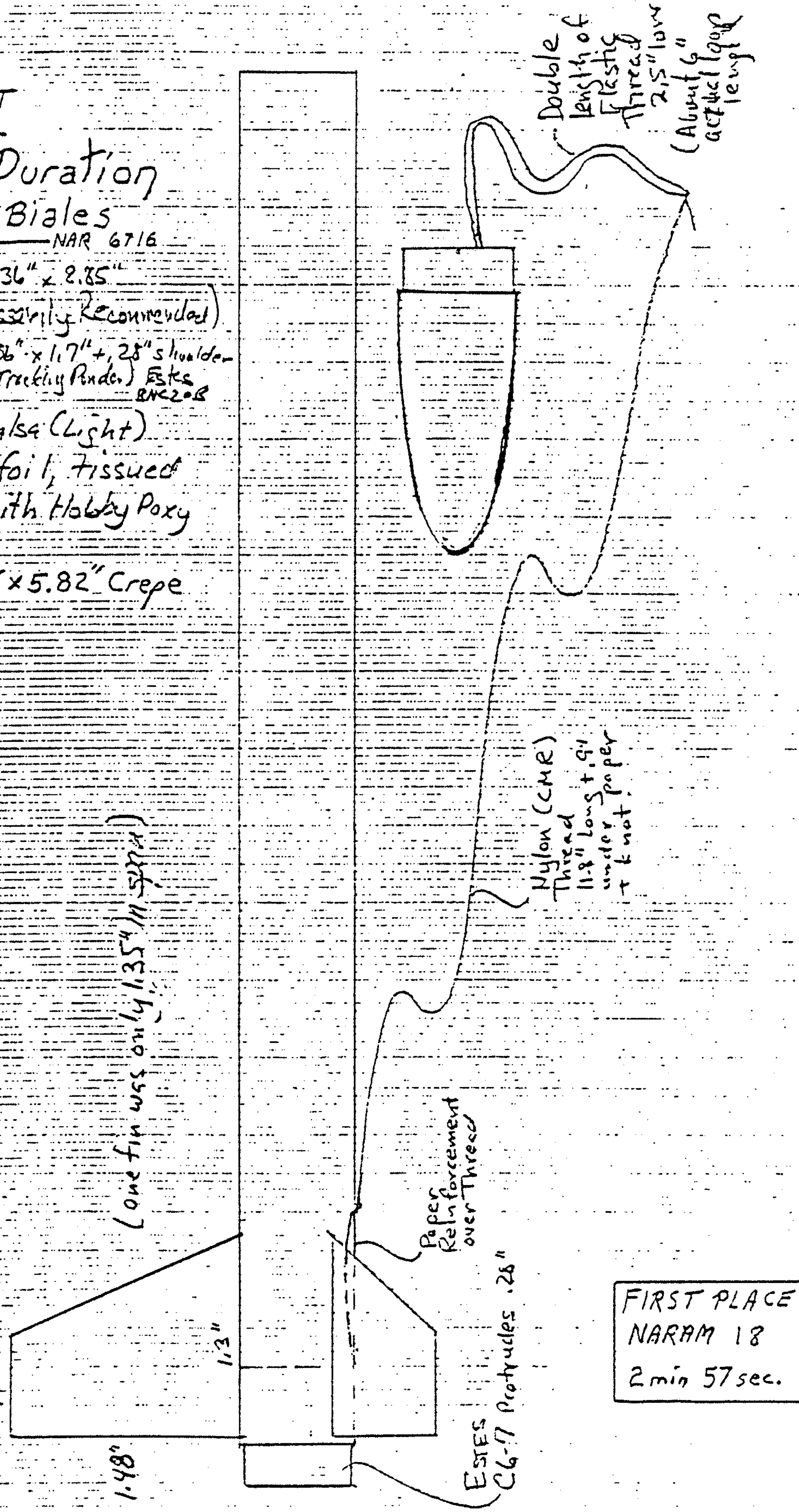
(See article on previous page)

Class 0 SD

Chris Flanigan
NAR 17540

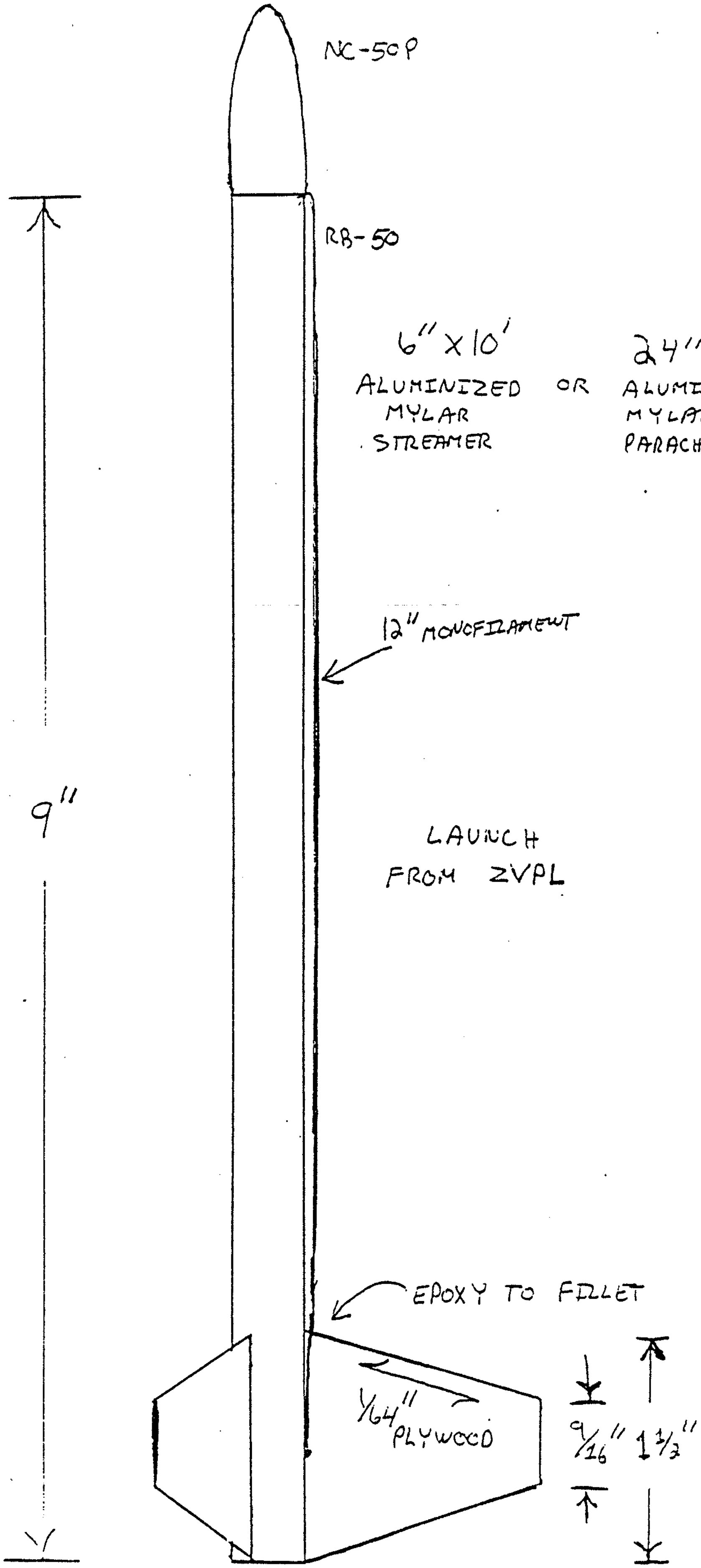
Class III
Streamer Duration
Bernard Biales
NAR 6716

Body: (Estes) .736" x 8.85"
(Peeled – Not Necessarily Recommended)
Nose Cone: .736" x 1.7" + .28" shoulder
Hollowed (Filled w/Tracking Powder) Estes BNC20B
Fins: .05" Balsa (Light) with nice air foil, tissued and filled with Hobby Poxy Stuff
Streamer: 56" x 5.82" Crepe



FIRST PLACE
NARAM 18
2 min 57 sec.

PD and SD



RB-50 ~ BT-5

CMR Body Tubes

RB	ID	OD	~BT
50	0,538	0,558	5
52	0,564	0,584	
74	0,710	0,736	20
77	0,740	0.766	
90	0.864	0.890	
92	0.894	0.920	
120	1.120	1.170	

CLASS 0 AND 1 SD
CLASS 0 AND 1 PD

—ye olde Reliable— —Flyable

FULL SCALE

DESIGNED AND INKED BY

Fred Shecter

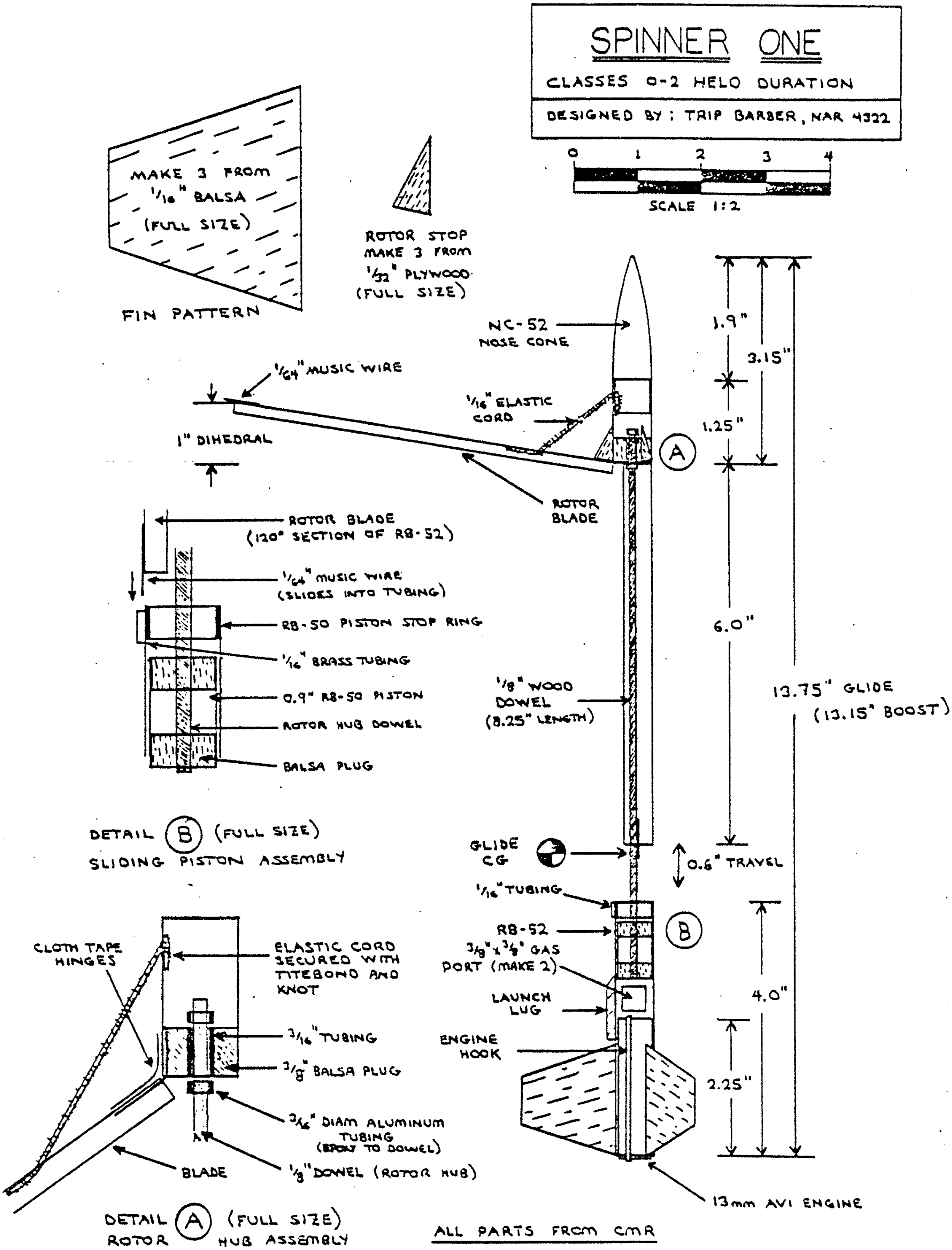
THE SPINNER ONE

by Trip Barber

As Helicopter Duration models go, the SPINNER ONE is a relatively simple and reliable design, suitable for use with ½A- through B- 13mm engines. It won C Division Class 2 Helo Duration at ECRM-X with a duration of about 45 seconds, using an AVI B3-3m. SPINNER uses a body tube (CMR RB-52) split lengthwise into three 120° segments for its rotor blades; these do not have an optimum variation of pitch with distance from the hub, but they have the major attraction of being simple and reliable, an advantage which has proved to be the most important in this event. It is essential that this model be balanced in the deployed (glide) position with a burned-out engine in place prior to flight; failure to have the center of gravity at or aft of the "glide CG" point marked on the drawing will result in an unstable (sideways) recovery. Addition of tail weights will probably be necessary, but be careful not to overdo it and cause the CG to be so far aft that the model is unstable in boost.

The heart of the SPINNER is a light-weight, warp-free 1/8" wood dowel, which serves as the rotor shaft and main structural member. The nose rotor hub assembly (detail A in the drawing) rotates freely about this shaft; the sliding piston assembly (detail B) is glued to its base and when pushed forward by the ejection charge gases, causes the folded blades to be moved forward enough (0.6 inches) that the pins on their tips pull out of the small tubes on the aft section of the body tube, and the elastic cord pulls them open. Once opened, the blades are held against their stops by aerodynamic loading; their dihedral provides some stability in gusty conditions.

Construction of the SPINNER is fairly obvious from the drawing, but a few tips on the more difficult points are provided. First, the rotor blades are hinged with two ¼" widths of cloth tape, one inside and one outside. The elastic cord is installed by punching a small hole in the hub body tube, passing one end of the cord through and knotting and gluing it, then passing the other end of the cord through a hole in the blade, pulling it just enough to put on very slight tension with the blade open, and holding down this end with a piece of tape while gluing it to the underside of the blade. This tape is removed when the glue dried. Be very careful when assembling the rotor hub that no excess epoxy or burrs on the metal tubing interfere with the free rotation of the hub around the dowel; graphite may be applied to the points of contact to improve rotation if necessary. Both the 1/64" music wire and the 1/16" tubing in the blade hold-down assembly must be reinforced with paper and/or liberal epoxy fillets. Finally, before each flight ensure that the sliding piston moves freely and has not become too coated with particles from the ejection charge gases.


SPINNER ONE
CLASSES 0-2 HELO DURATION
DESIGNED BY: TRIP BARBER, NAR 4322
0 1 2 3 4
SCALE 1:2
MAKE 3 FROM 1/16" BALSA (FULL SIZE)
FIN PATTERN
ROTOR STOP MAKE 3 FROM 1/32" PLYWOOD (FULL SIZE)
NC-52 NOSE CONE
1/64" MUSIC WIRE
1" DIHEDRAL
1/16" ELASTIC CORD
ROTOR BLADE
A
1.9"
3.15"
1.25"
ROTOR BLADE (120° SECTION OF RB-52)
1/64" music wire (SLIDES INTO TUBING)
RB-50 PISTON STOP RING
1/16" BRASS TUBING
0.9" RB-50 PISTON
ROTOR HUB DOWEL
BALSA PLUG
1/8" WOOD DOWEL (8.25" LENGTH)
6.0"
13.75" GLIDE (13.15" BOOST)
DETAIL B (FULL SIZE)
SLIDING PISTON ASSEMBLY
GLIDE CG
0.6" TRAVEL
1/16" TUBING
RB-52
B
3/8"x3/4" GAS PORT (MAKE 2)
LAUNCH LUG
ENGINE HOOK
4.0"
2.25"
CLOTH TAPE HINGES
ELASTIC CORD SECURED WITH TITEBOND AND KNOT
3/16" TUBING
3/8" BALSA PLUG
3/16" DIAM ALUMINUM TUBING (EPOXY TO DOWEL)
BLADE
1/8" DOWEL (ROTOR HUB)
13mm A VI ENGINE
DETAIL A (FULL SIZE)
ROTOR HUB ASSEMBLY
ALL PARTS FROM CMR