

A large, heavy, 45-powered stunter designed for those all-too-frequent windy contest days.

There are many trends in stunt design. One of them leans toward military jets. Scale-like details and five or six ounces of pressure-sensitive lettering are very important for gaining "impression points." Jets lend themselves to all sorts of delightful lettering, beware jet blast, cockpit emergency release, ammunition storage, etc. The Marut, big and heavy, follows my reasonably successful Navy A6A Intruder.

Looking through a series of books of three-views, I came across the new jet designed by Kurt Tank of FW 190 fame. This one was designed for the Indian Air Force with a Mach 2 capability and had the long

straight lines necessary to show off the pattern maneuvers. The plane's profile really grabbed me, so I drew it up as a stunt model.

Before going into construction details, I should explain some of the reasons I design big models in the 850-sq. in. class.

A couple of years ago I worked out the design for a model based on the Navy A6A Intruder, which featured an exhaust system of magnesium tubing to feed all gases and gook out of the back of the plane. With the added weight of the exhaust tubing and a very unfortunate experience in finishing, the plane came out so heavy that I was afraid to weight it. Since I could still lift it with one hand, and

by RON ADAMS

MARUT The Wind Spirit



it was all I had, I flew it anyway. Wonder of wonders, it flew rather well, particularly in the wind.

The first contest was the Niagara Falls Invitational held by Dave Gierke and attended by most of the top fliers in the country. I managed a third place, which did not make me at all unhappy. The next contest was the Michigan State Meet and I came in second, just a couple of points behind Jerry Worth.

Work got in the way of the rest of the season until the Nats. I went there with literally no flights in practice and ran into my first experience with loose head bolts—no start. Finally found the trouble and was so

A basic factor in aircraft design is a dimensionless unit called the Reynold's Number. R_n equals the air density times speed times chord divided by the air's absolute viscosity. This number is used to designate changes in the character of airflow around an airfoil. In general, the higher the R_n , the more performance you can expect to get. There is a maximum limit to this, but we are a long way from supersonic stunt.

According to the formula, we have several ways of operating at a higher, more efficient R_n . For example, we could do all our flying on a cool day in Death Valley below sea level where the air density is high. Another way is

adjusted by proper balancing of the plane. Lift is increased primarily by the addition of wing flaps and also by the simple expedient of increasing span. In full-size aircraft design, the rate of climb (i.e., best use of available lift) is determined almost exclusively by the span. The longer span airplane will climb better than its sister airplane, even though the two may have equal power and wing loading. Therefore, if you are going to design a large airplane, put a lot of the size into the span. The limiting factor, of course, is its transportation—it won't fit in a sports car.

The third factor mentioned is the prop's diameter; again, size helps. The bigger the diameter of the disc area, the better the turning tendency of the model. This effect is more than enough to offset any adverse gyroscopic effects (which could be minimized by using a very lightweight propeller).

We could go on and on about design features and theory, but any adequate treatment would require a series rather than a single article. Most have already been covered in much detail in model publications. I would certainly suggest the two books on design published by the Experimental Aircraft Association in Hales Corners, Wisconsin as good starting points for design considerations without becoming involved in advanced math.

The lines of the Marut are loosely patterned after an Indian Air Force Mach 2 fighter.

In the final analysis, the acquisition of hardware on the trophy shelf is the best proof of the pudding. This size ship, and the basic design principles involved, has won in the past. The coming season will determine whether or not the Marut will come up to expectations—assuming I get some practice time on it.

Construction

A false wing section is built first. Ribs 1 and 2 have 1/2-in. extensions above the rib centerline indicated on the plans. The spars also have this extension above the centerline out to the second rib notch. Cut out the half ribs and spars along with their extensions and assemble the units, extensions down, on a flat surface. Cover with 3/32" balsa just as you would the bottom center section of the actual wing. Note the taper in the panels. Sand the unit to a good surface to correspond with the final wing shape.

Next, build the engine mount section. This model is set up for a Veco 45, but the spacing on the mounts can easily be changed to fit any other engine used. However, do not try anything smaller than a 45. In fact, the plane would work even better with a larger engine. That's another nice thing about a big plane—you have room for engines and tanks.

The mounts, plywood formers, tank platform, and 1/16" doublers should be assembled as a unit ready to mate to the rest of the fuselage. Make sure they are perfectly aligned. There is no need for engine offset since the weight of the model will hold it out

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shook I left out the triangles. Second flight left me one point out of qualification. My fault, through lack of practice, and definitely not the fault of the plane.

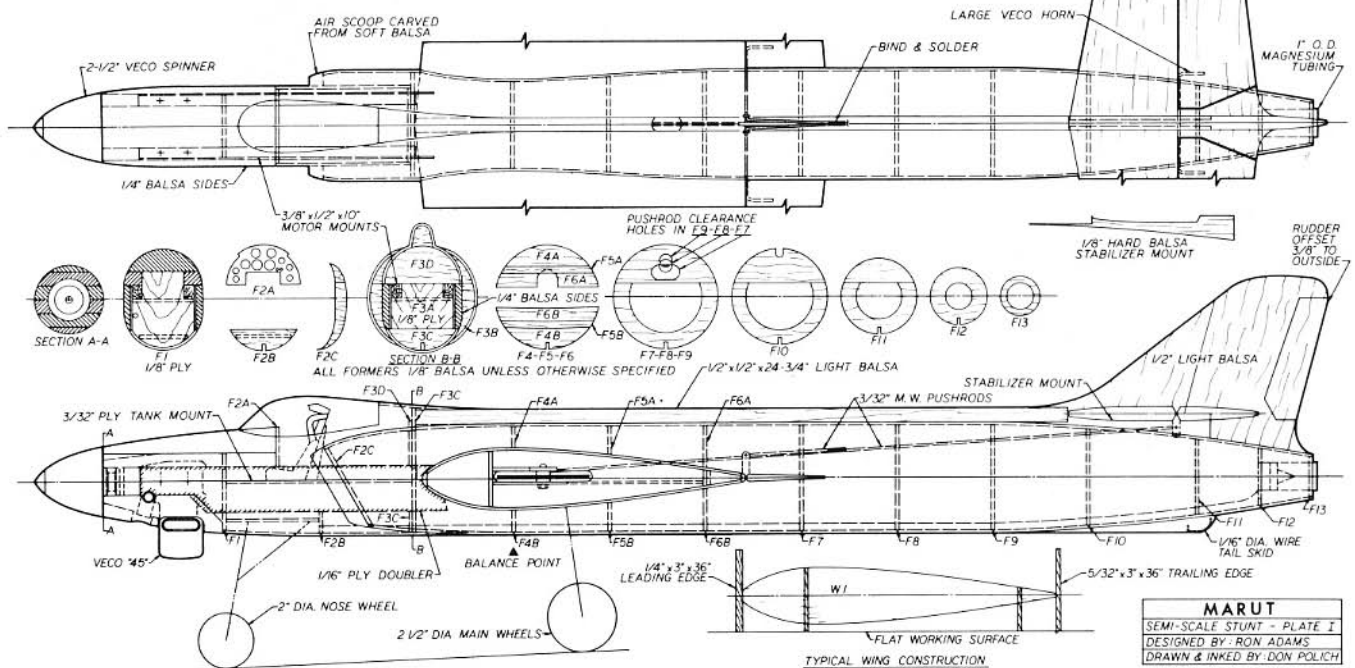
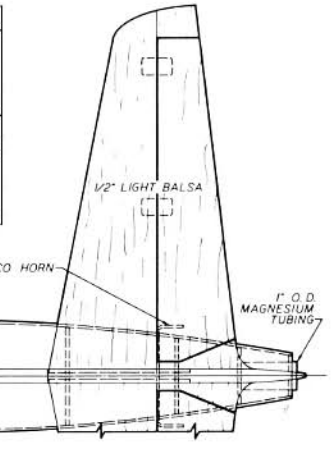
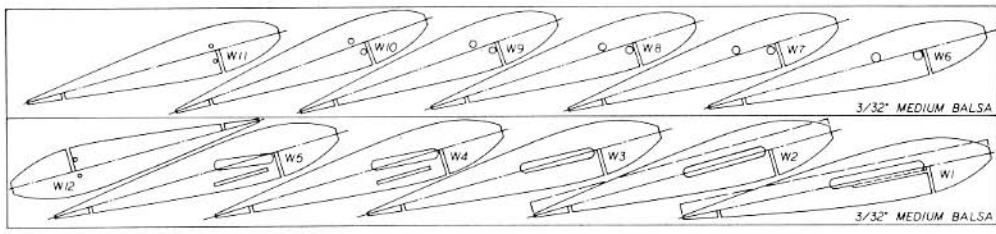
After the season, I finally got up enough nerve to weigh the model—98 oz.! Twice the weight everyone else was used to. According to all the scuttlebutt, the thing should never have left the ground, let alone place at a major contest.

Actually, there was no real reason to have the plane weigh that much. I had built it in a week after loosing a wing. In trying to rush for the Invitational, I tried a new synthetic finish that didn't work too well. I just built up a lot of weight, trying to quickly cover the bad things happening underneath. The factors that enabled a heavy model to fly reasonably well, I believe, appear to be large size, long span, and a good disc area on the prop. Let's take a look at each item.

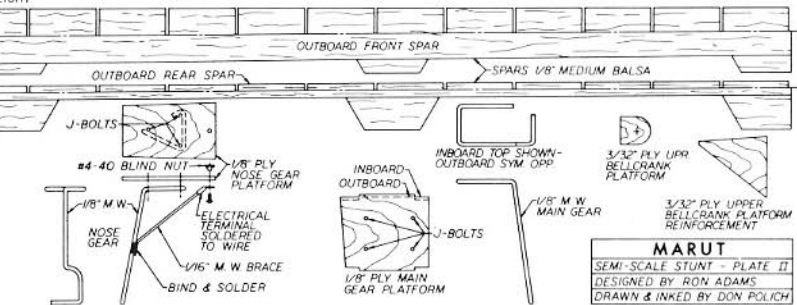
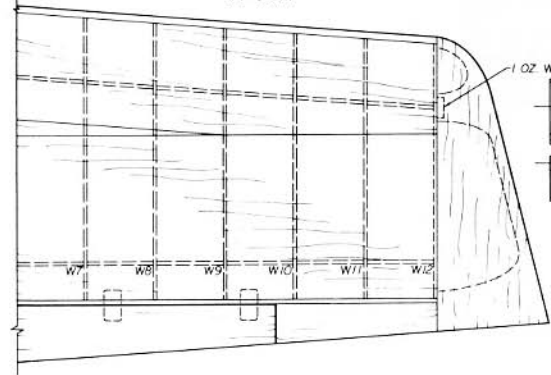
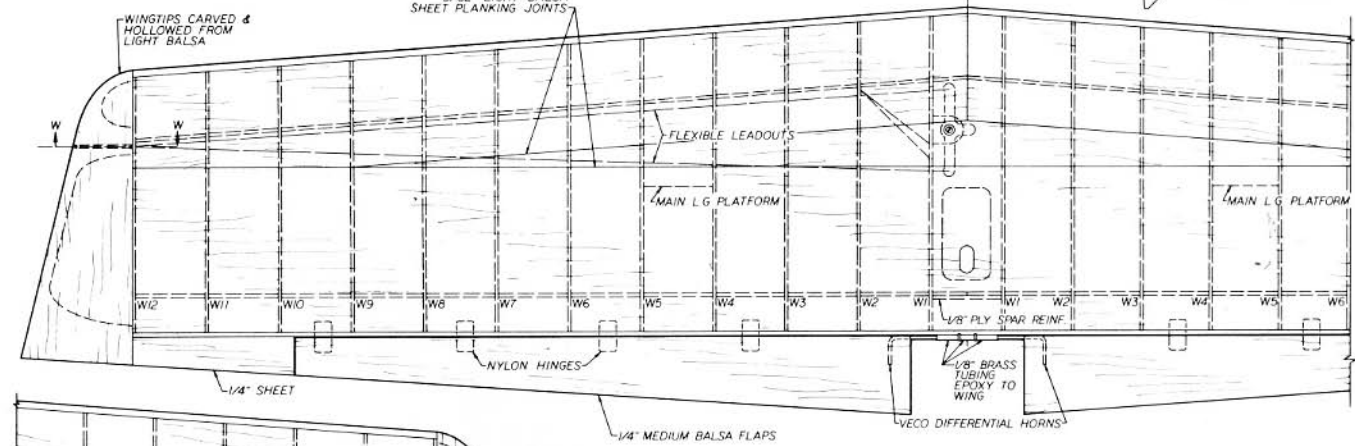
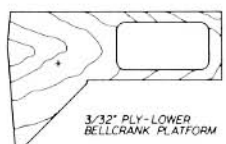
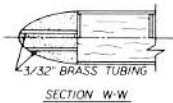
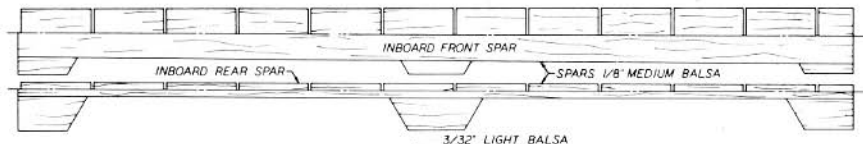
to fly faster—just as we do in a wind to get better lift and control to avoid the ground. This will hurt us in general, since most judges like to see a fairly slow pattern to give them time to write down the scores, evaluate the maneuver and take a sip of soda or whatever.

The third practical way is to increase the wing chord. This increases the R_n effectively and will let the plane fly a little better. To oversimplify the whole deal, in aircraft design, the bigger the better for efficiency. Besides, a judge is accustomed to seeing little bitty things fly by—when this monster roars by, you are sure to have his attention.

The second factor, large span, is probably the most important of the three items. In our planes we are interested in performance characteristics—smooth level flight with no tendency to hunt, and high lift capability to get us through the corners. Smooth flight is largely a function of CG location and can be



MARUT
SEMI-SCALE STUNT - PLATE I
DESIGNED BY RON ADAMS
DRAWN & INKED BY DON POLICH



MARUT
SEMI-SCALE STUNT - PLATE II
DESIGNED BY RON ADAMS
DRAWN & INKED BY DON POLICH

Marut

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with no trouble. You will notice that the front end has a lot of beef to it. This absorbs a lot of the engine vibration, cutting down on stress cracks. In the past, I usually end up adding lead to the nose for balance. This time I thought the weight should do some good, instead of just getting a free ride.

Make a 5½ oz. tank and run the fill lead back to be concealed by the inboard air scoop. The vent line goes straight down and can be turned into a pitot tube arrangement. Coat the tank compartment with fiberglass resin and install the tank system. Add the nose gear setup and fiberglass in place. Add the ¼-in. side planking and strip plank part way up to define the bottom curve. Shape the sides, using a template to make sure the curve is correct.

On a perfectly flat work surface, draw a straight line from the edge long enough to provide a centerline for the fuselage. Place the engine unit on this line, motor mounts directly on the work surface. The protruding

former should rest at the edge of the table and the centerlines should match. Place the false wing section in position aft of the engine section; line it up and secure both units to the table. Remember, you will have to pick it up later. It is very easy to bury the hold-down pins under the construction—this goes for the wing assembly, too.

Cut the bottom keel and all formers. Notice in cutting the formers that the cut line is ½-in. above the centerline in each case except the last two. The last two formers are blocked up by ½-in. scrap blocks, making it easy to drop in the magnesium exhaust tube later.

Pin the keel and formers in position over the centerline on the table. When perfectly lined up, glue in place. Cut extra pieces of ½-in. block to place on either side of the fuselage between each former. These will help position the first planking strip to be glued on. The top of this strip at 130, corresponds to the centerline of the model and is the lowest one to be placed. Planking to the bottom of the formers (bottom in this case, meaning toward the table) will make installation of the flap horns difficult.

All planking is 3/32 x 3/8" and is beveled to fit on the edges. Do not glue the planking to the wing form. Leave a small section of planking over the wing section incomplete to facilitate final mating of the wing and fuselage. (If that section is completed, there is no way to fiberglass the seam later.) Once all the planking is complete, except for the section mentioned above, the fuselage bottom is a rigid, perfectly straight unit with a preformed wing cut-out that will insure accurate line up later. Remove from the table and set aside.

Next step is the wing. Cut the spars and ribs, marking centerlines as you go. Make sure the legs on the spars are cut accurately, since these provide the basis for the wing jig setup. It also helps to score the spar line along the top of the legs for ease of removal later. If you do this, put some Scotch Tape over the cut line to hold the legs in place.

Again, mark off a straight line to correspond with the rear spar position. This line should run the full span of the wing—a little extra for good measure. At about the center point of this line, erect a perpendicular line to correspond with the fuselage centerline. Glue the rear spar sections together with a 1/8" ply doubler on the aft face between the slots for the center ribs. Pin the spar upright on the work surface, aligned with your reference line.

The next step is to place (not glue) the ribs and front spar in position. Check fit and alignment. Centerline should meet centerline. All rib centerlines should be parallel with the table. (Note that there is a slight taper in the wing thickness.) All of the taper is on the bottom of the wing, so the spar centerline is higher at the tips than at the center. Once everything is perfectly fitted, glue all ribs outboard of W5 and the center seam of the main spar.

When dry, remove the center ribs and fiberglass the center sections of both spars, front and back, using both cloth and resin. If you omit this step you will have a terrible surprise one day when the wing fails. I know from experience—that's what led me to a rush job on the Intruder. Just before the fiberglass is fully set, trim out the excess from the rib notches. It will also save a lot of work later if the resin job is done neatly with no runs and drips.

While the resin is hardening, form the landing gear wire to fit the platforms and predrill the holes for the hook bolts to be installed later. The plane is designed to sit tail low, minimizing the length of the main gear, yet providing ample clearance for the 12-6 prop to get the plane out of grass. This ground attitude also helps the takeoff smoothness. It is necessary to come in for a slow landing, however, to prevent going airborne again. A full-stall landing is the way to land real ones, and there is no reason for making a hot landing with a model. If it is fully stalled just at touchdown, full-down elevator will keep it there. Wait until it is on the ground though, before putting in full down.

Although off the subject of construction, you might be interested in how to get a full-stall landing. After the engine quits, make a smooth, gradual descent to about a foot or less from the ground. The smoother the surface, the lower the descent; best is about six in. Keep it there, slowly feeding in more and more up elevator to maintain altitude. This increases the angle of attack to get more lift at slower speeds, thus generating more drag which slows the plane still more. This means still more up elevator, thus, more drag.

In a few seconds, you will not have more up to feed in and the plane will settle, all flying speed gone. This will result in the main gear hitting first with the nose gear settling down gently soon after. In a no-wind situation it is possible to hold the nose gear off for several feet. If you are coming up into the wind on landing, put in full down to hold the plane on the ground. When this type of landing is done properly, you will find few judges who won't give maximum points.

The next stage in construction is to glue the ribs and plywood floors in place, checking for accuracy all along the line. The leading and trailing edges follow. These are made from three-in. wide balsa with the edges dressed so they are all parallel and of equal width. (Check it with a straight edge and ruler.) When the wing is turned over for the bottom planking, these sheets are used to maintain alignment. Glue them in place on the ribs, making sure the bottom edges are in good contact with the table surface.

While they are drying, add fiberglass to the gear platforms and to the bellcrank platform. Remember, you are going to take a 50 lb. pull test on rusty scales. I have been pulled almost 100 lb. at a couple of meets. It does no good to protest the accuracy of the scales once the controls are out of the wings.

In line with this attitude, I use a steel bellcrank made by Art Adamisin of Detroit, who would probably do the same for you if contacted. (Don't tell him you are going to cut it down to a standard 3-in. size, since he is a great believer in 4-in. bellcranks!) You might also try his Y-shaped unit which works well.

Next, add the leading and trailing edge planking—3 in. for the front and 6 in. for the rear. This will leave just the right gap for installation of the gear, lines, etc., and can easily be plugged later with a 4-in. sheet. Be sure to bevel the sheets for a good fit with the edge planks, leaving no gaps. Allow everything to dry overnight.

Remove the wing from the table and invert it. The wing is realigned with the reference marks and pinned down by the leading and trailing edge planking. There should be no need for any adjustment to

make the wing contact the work surface, provided all work was done carefully in the earlier stages. Remove the jig legs from the spars and plank the bottom in the same manner as the top; let dry.

At this point the wings will maintain a pretty good alignment, so remove the wing from the table and add the control system and landing gear. Out of scrap ply make a brace to take the sheer loads on the top of the bellcrank bolt. One goes from the bolt head



Inverted Veco in well-rounded fuselage could easily be muffed.

to the first inboard rib; another angles from that point to tie into the main spar. Bond with Epoxy. I bushed everything with nylon, including the fairleads in the fuselage. Once everything is in and working smoothly with no binding, replace the wing on the table and recheck alignment. Complete the bottom planking. A little time to make a good fit is good at this point.

When dry, turn over the wing and finish the top planking. Trim the leading and trailing

edges to fair into the airfoil. Make sure the leading edge is done carefully to a smooth, rounded shape. The trailing edge is not rounded. The wing, complete with gear, etc., should come in at about 17 oz. at this stage. Do not add the tips until the plane is completely assembled.

The following step is to mate the fuselage with the wing. If everything has been done carefully up to this point, they should drop right into place. Nevertheless, the more care taken at this stage, the better the performance you can expect later. I set everything up on a pool table—as flat a surface as I could find. The main gear was blocked on wedges, which I slid in and out to get perfect alignment with the table surface. After much fiddling and help from whomever I could corral, all centerline measurements were equal, and a large triangle showed 90 degrees between wing and fuselage. Glue was run-in and the kids were banished to other parts of the house while everything dried.

Add the upper former parts and complete the planking. Don't forget to leave a couple of strips of planking off until the controls are in and adjusted. I used Veco's differential flap horns, but you can make up your own if you wish. If you use a split flap horn with clevis pins on each horn plus the elevator, you have three points of adjustment. This is very handy. Prior to completing the planking, I ran some fiberglass and cloth along the fuselage-wing joint.

Make the elevator and stab as accurately as possible by using round toothpicks to reinforce the stab extensions around the elevators. The stab is supported by 1/8" pieces of hard balsa cut to fit the curve of the stab and fuselage. These pieces are glued to

the fuselage in the proper position and allowed to dry completely. Line everything up again on a flat surface. Leaving the wing tips off until this point helps, because you have the tip rib centerline to work with in getting everything parallel to the table. Line up the tab by sanding a little at a time (as needed) from the supports. When set, glue in place and let dry.

Finish the planking, add the rudder and dorsal block. I reinforced the stab-fuselage junction with glass cloth and resin. This might not be necessary, but why take the chance?

Build in fillets and fill all cracks and crevices. Take all the time necessary at this stage, since anything left undone will show up later in the final finish. Sand the whole thing completely.

Finishing is pretty standard. I don't have any special tricks or secrets, but a brief description might help those not too familiar with the process.

Brush three coats of clear over the bare wood, sanding after the third. Cover the wing with SGM paper to prevent seams from pulling at the butt joints. Add two coats of clear over this. I used Sig Super Fill for filler, brushing on two solid coats and sanding completely with 320 used dry. At this stage, mount the elevators and flaps using nylon hinges with steel pins available at hobby shops. Use round toothpicks to anchor them in place. After making sure they are trimmed and sanded to match the surface, brush on two coats of talcum clear. Mix talcum power with clear dope, to a thick brushing consistency and add some silver dope. (Putting the silver in emphasizes every defect.) Sand and refill until there are no marks left. Any major defect can be filled with a thicker mixture of talcum and dope. Spend a couple of days with this step, moving the plane into different lighting situations. You'd be amazed at how many things you can find with the plane in another room—things you'd have missed otherwise.

I sprayed two coats on Sig Silver over the entire plane as a base color; then added a touch of blue to the silver to get the major variation in the wing panels to correspond

roughly with the different metals used in a real jet. Red mixed with silver was used in the tip areas to maintain the metallic feeling in the trim color. Do not sand metallic paint.

Once the color is on you can add all the pressure-sensitive lettering your little heart desires. In a moment of wild exuberance, I decided on the insignia of the Tripartite Evaluation Squadron for the wing. Three days later I had it masked and painted; to heck with all that work in the future.

The whole plane had three coats of SPL 990 sprayed on for a gloss coat which cut about 10 oz. off my normal dope finish. This was wet-sanded with No. 600 paper and rubbed-out to a high gloss.

I have gone on at great length about some items and completely neglected others. For example, I have not discussed the cowling or cockpit details, figuring that if you are going to build a plane of this complexity, you already know about them.

The end result is a large 80 oz. monster that has caused a lot of comment—some favorable. Certainly no one is knocking the appearance of the plane in terms of impressiveness. One thing everyone seems to agree on, is that a heavier plane flies better in the wind. Just let me win all the windy contests. Others can take the calm ones—if they find any.