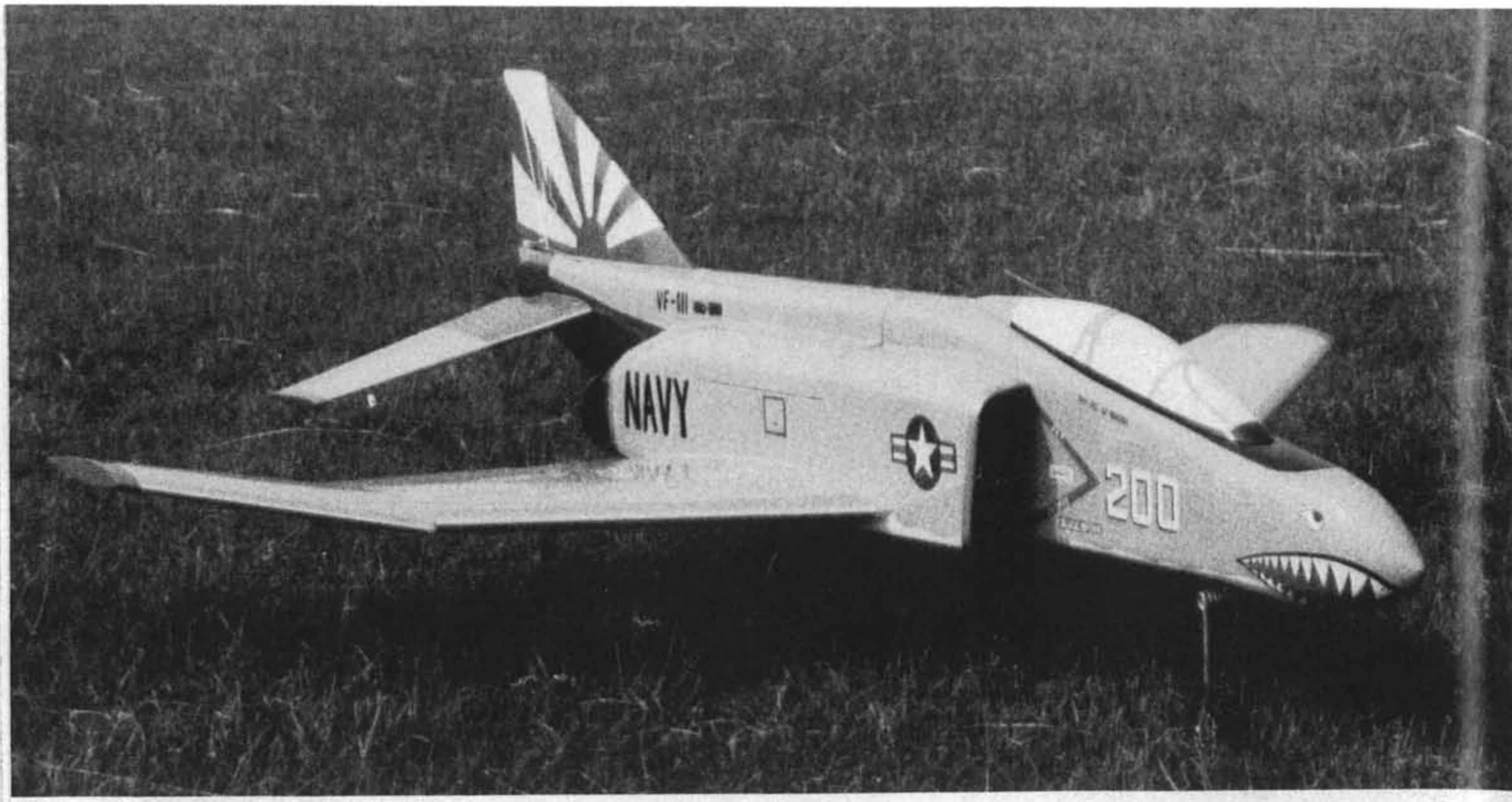


PHOTOGRAPHY: LOUIS LEVINE AND FRANK FANELLI

a ducted fan "Hot Rod":

Performance Phantom

By Eric Baugher

Got Phantom fever? This one's got the looks and performance wrapped up in a skillfully designed airframe. Build one!

YEAR: 1967
LOCATION: South Vietnam
OPERATION: Bolo
REASON: Respond to increasing MIG harassment of F-105's on bombing missions.
OBJECTIVE: Destroy MiGs by luring into combat in a fighter sweep similar to those in WW II and in MiG Alley over Korea.

"On the morning of 2 January, the BOLO aircraft went north, following the usual flight and call sign patterns of a typical rolling fighter bomber mission. Because of the weather, the MiG's were slow to respond - when they did, a surprise was in store. Instead of the lumbering Thuds, *they found a sky full of F-4's armed to the teeth and ready to fight. In the massive air battle that ensued, seven MiG-21's (half of the N. Vietnamese inventory) were brought down, all of them by F-4C's of the 8th TFW using AIM-7 Sidewinder air-to-air missiles. Not a single American aircraft was lost. The superiority of the* Phantom, *like the* Sabrejet *in the previous war, was established." ("History of the U.S. Air Force," Bill Yenne p. 85, copyright 1984. Bison Books Corp.)*

If there ever was an intimidating looking airplane, it has to be the F-4 *Phantom!* From its first production, until well into the seventies, the F-4 *Phantom II* would be known as the primary front-line fighter in the free world. Over 5,000 were made and it has come to be one of the most recognizable silhouettes in aviation history. Reduced to second line status with the introduction of the F-15 and F-16, it still, after 25 years, is a primary fighter in many nations around the world.

Such is the inspiration for this project. I've always admired the menacing look that the F-4 presents. Being a closet jet-jockey, I would be willing to bet that there are a lot of guys who would like to have the opportunity to experience an exhilarating ride in one. I know that this would not be possible for me so why not build a model of one. Not one that's so scale and loaded with details and options that it approaches unflyable status, but one that has the distinctive outline in the air yet, by design, flies like a pattern bird. In my eyes, it's not worth the trouble if it's not fun to fly. It has to *Perform!*

Let's talk about what performance means. I have been flying pattern for several years. Aircraft designed for this event are thought of as having above average performance. Pleasant wing loadings, extraordinary power, unmatched aerobatic capability are among the characteristics. Now let me dispel the myth that ducted fans lack this flight performance. My F-4 will stand up to about 90% of the pattern airplanes out there.

I realize that's a tall statement to live up to, but consider the following:

1. Take-off roll @ 60-70 ft (on grass!)
2. Unlimited vertical at 80° angle
3. Top speed of 150 MPH (Verified by radar!)
4. Landing speed at @30 MPH
5. 300 + ft. loops
6. Horizon to horizon - 4 pt., 8 pt., & slow rolls

Sounds like a pattern plane, doesn't it! It's my F-4!

This is not to say that I haven't seen a ducted fan that lacked performance. As a matter of fact, I've seen a whole lot of them. I would like to point out that almost all of them appeared to be terribly underpowered or grossly overweight. Which ever way you perceive the problem, they definitely did not have jet-like performance. You may note that just about all of them were scale models to some degree. They all were designed around parameters of some full scale jet (F-15, F-16, etc) where looks were more important than how they flew. As a matter of fact, the popularity of ducted fans has really grown out of the ranks of the scale modelers. I must commend these innovators for proving the concept of propelling a model with an internal thrust package, but they may have been their own worst enemy. Scale modelers, although worried about building light like everyone else, are more concerned about those little details that make it look real. Those details add up to weight. Those options add up to complexity and, again, weight! I must admit though, an airplane with a recognizable shape does have a certain universal appeal.

With performance in mind, the design criteria was as follows:

1. It must be light - overweight airplanes with high wing loadings are not fun to fly and require excessive amounts of power and speed and have much higher stall speeds;

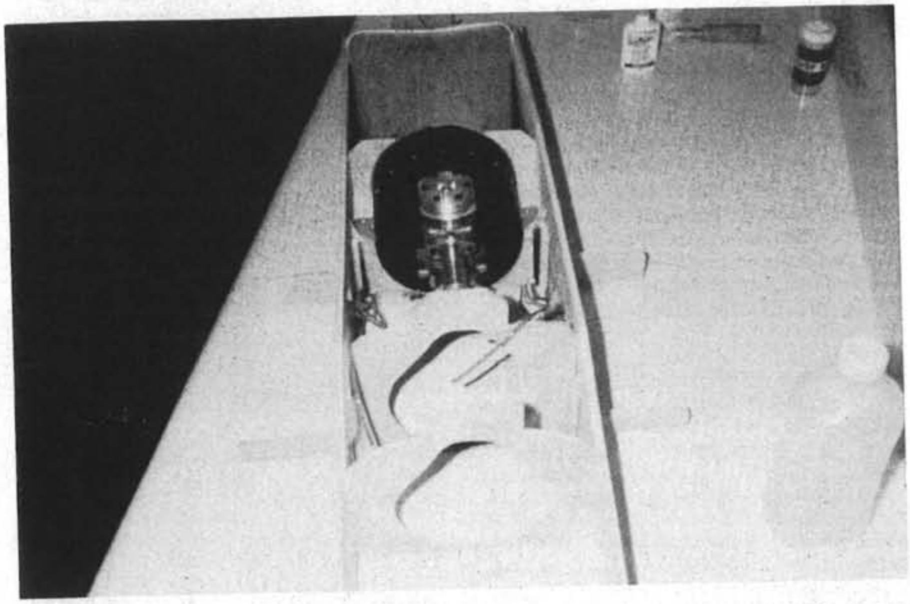
2. It must have a low drag coefficient and it must be compact. Only necessary equipment would be carried and efficient use of internal space and components would yield a frontal area with less drag. External surfaces must be clean, smooth and flowing. Eliminate as much parasitic drag as possible (i.e. radar antennas, bomb racks, etc.)

3. Power unit must be reliable & strong - this was not a problem. I chose Jet Model Products' Dynamax fan combined with the O.S. .77. this unit has been flown in another airplane for approximately 75-80 flights. It had proven to be a very potent power source that also had a high degree of reliability.

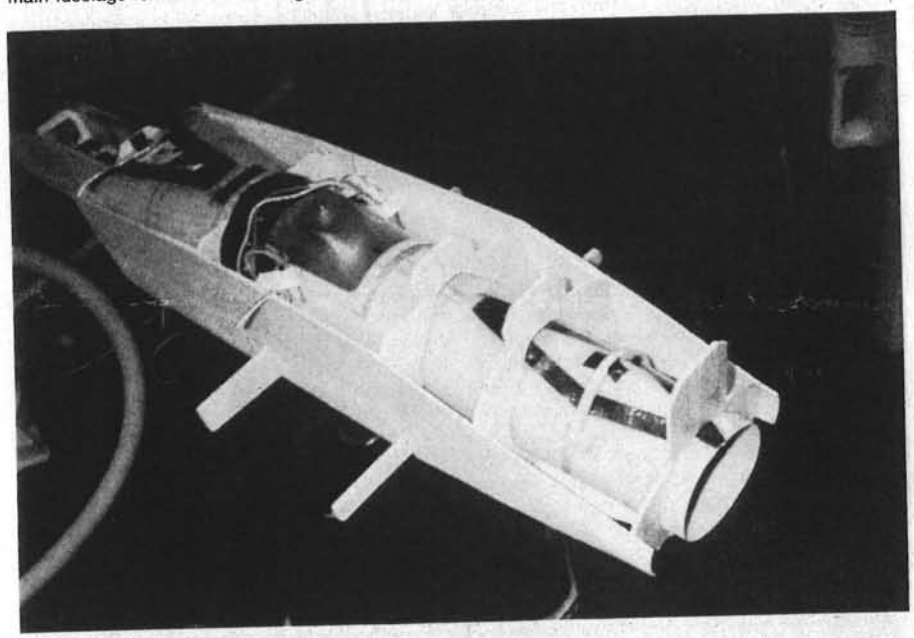
When it comes to ducted fans, a reliable power source seems to be half the battle. Let's face it, when people see a ducted fan being prepared for a flight, they stick around expecting disaster. Even if a plug blows when starting, someone is always there to say: "See, ate another plug!"

Now let's dispel the second myth surrounding ducted fans, the one where people think that the engines are super sensitive and require a person with a racing background to operate. A racing background may help understand what is going on at the higher RPM's but is not necessary to successfully run a ducted fan. Today's super-fans (Cook-Dynamax, Violett-Viojett, Jet Hangar-Turbax III, etc.) are designed around special large displacement, high output engines. The loads that these engines take on are very similar to a pattern "60" turning 14,000 RPM. Tuning the engine is done almost identically and is not more difficult. Think about putting a 5 inch fan on that .60 instead of an 11 inch blade. You will get a big RPM increase. The ducted fan engines are pipe-timed to run at higher RPM's. Credit must be given to the pylon and boat racers. They have refined engine technology.

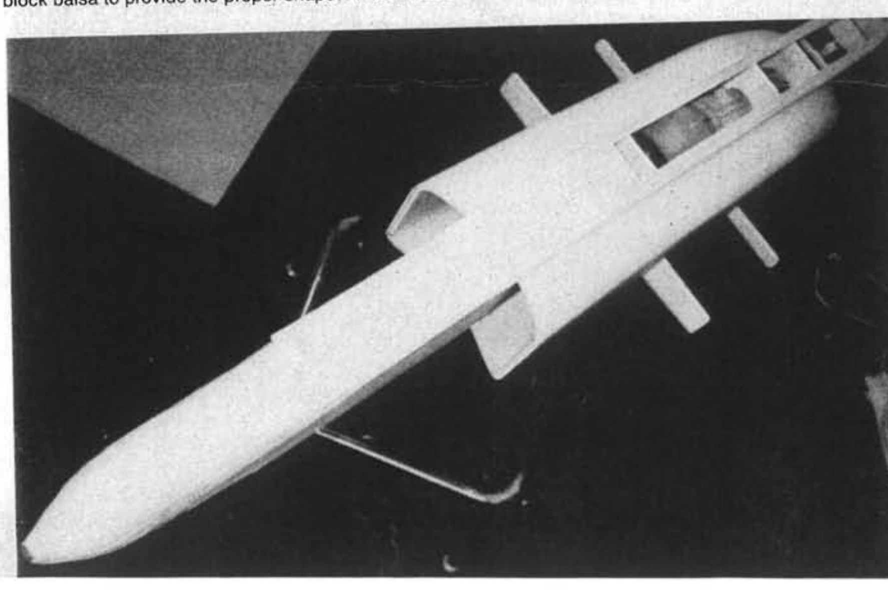
I have almost 100 runs on one engine. It has never been apart or rebuilt. It's never even been out of the airplane! I run 5% nitro. Cooling is not a problem with 200 MPH



In this photo of the preliminary installation of the Dynamax, it is important to note the 1/64 intake liner at the top of the photo. It has not yet been cut to install the front fuselage with the intake center section. The four main fuselage formers are first aligned and glued to the 1/8 bottom sheet.



The black outline along the top of the thrust tube **(above)** is the tuned pipe blister sealed to the thrust tube with carbon fiber mat. The blister will have to sized and shaped to suit the pipe you use. Later on, the tail structure is added to the main fuselage as a sub-assembly. Up front **(below)**, there's some liberal use of block balsa to provide the proper shapes. Hollow the block wherever possible and choose good light balsa.



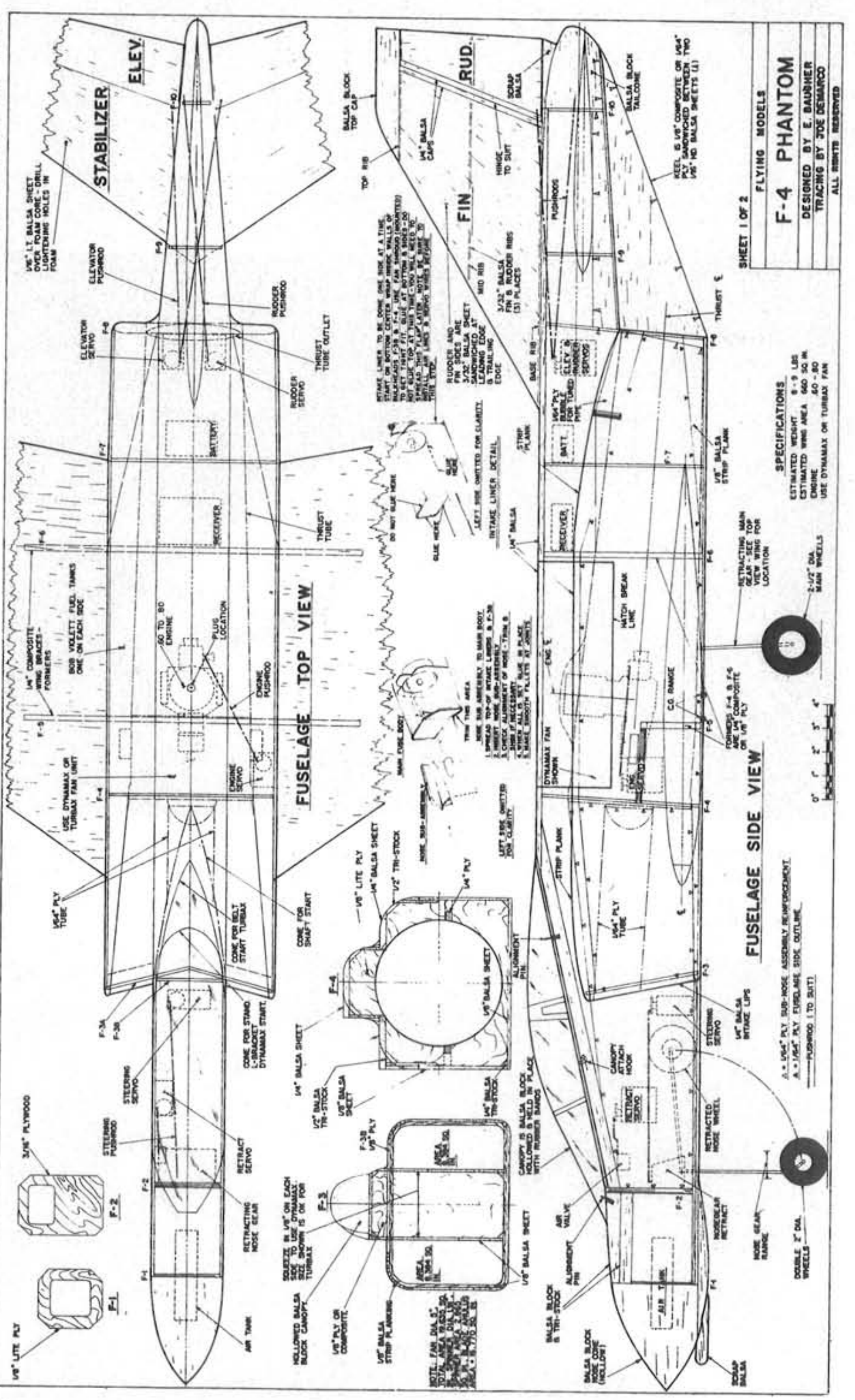
winds being pushed around the engine head. Fuel consumption is higher at 23,000 RPM (about 2 oz/minute) and I do change plugs often (only to be safe) but this is a small price to pay for the thrill of a crowd-pleasing jet flight.

True jet-like performance is now available in our ducted fan models. The key to impressive performance is efficiency. I'm sure that you know that a lightweight, low drag model will fly better, faster, and land slower than an overweight, higher drag model (assuming comparable power). The lighter, low drag model is more efficient at producing usable lift.

Applying the concepts of efficiency to the fan and ducting systems will yield performance gains. Any engineer will tell you the most efficient way to convert horsepower to thrust is a single blade prop (heck, the control-line guys know this). A large blade is more efficient than a small one. So now we are trying to power a model with a small diameter, high number of blade fan unit. Obviously, there will be a loss of efficiency and anything we can do to recover it will be good. Luckily, most of the hard work was done when you purchased your fan unit. It is engineered with a certain level of efficiency recovery.

You may think that it is difficult to gain any more performance out of it. For most people, a fan unit with 50% efficiency will be plenty. (Believe me, some of these units really put out!) There will be a few who will look for slightly improved performance and higher top-end speeds. This can be attained through efficient airflow to and from the fan unit. Tailpipe pinching is a common practice to improve tailpipe pressures, thrust velocities, and hence performance. The other area, which has not had very much attention, is the intake. The intakes are key to added performance.

FULL SIZE PLANS AVAILABLE THROUGH CARSTENS FLYING PLANS ORDER PLAN CF-757



Much attention was paid to the intake and tailpipe of my F-4 to improve performance. The objective was to provide a clean, unbroken, unseamed path from the side of the airplane to the fan blades. Area of the intakes is only 10% over that of the fan blade swept area (minus the spinner). No cheater holes are necessary. The front fuselage goes into the duct and "V's" up to the blades. A conical fairing on the intake goes around the impeller spinner, essentially taking it out of the airflow.

Since the spinner was secluded and the deletion of hatch access seams were necessary for optimum airflow, a shaft starting set-up had to be made to positively start it. This was handily taken care of by my friend, Jeff Hickam. Another area that needed attention was the intake lips. Sharp edges cause turbulence. Ideally, they should be like a wing's leading edge. Semi-symmetrical favoring the inside works well.

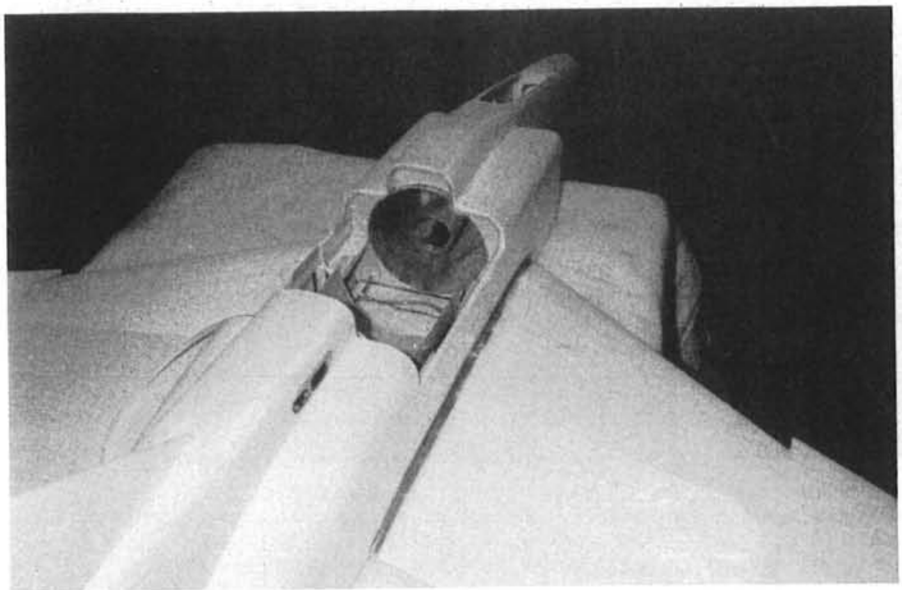
I'm sorry to say that I'm not the genius who created the idea of super intakes. The concept was actually borrowed from the popular Bob Violett *Sport Shark* design.

There is more that can be done. Air direction around the engine helps. Percentage gains in efficiency from this point will be small. There is also the argument of pusher vs. tractor. How about taking the engine out of the duct? These two items could be several articles in themselves. Without elaborating on ducted fan design theory, (heck, I'm not an engineer anyway!) suffice it to say that the system in the F-4 works. Those who have seen it go, including the doubting Thomas's, have all walked away believers.

Today's model jets are constantly improving. They are on the cutting edge of available technology. The most unique thing is that they have drawn people from all backgrounds to improve the technology. Racing types helped with the engine performance. Scale modelers faithfully made them popular (everyone loves a scale model). The pattern crowd is being drawn into it as well as I think that you will be seeing some very good performing jets. The F-4 is one of them. Because of their universal appeal they will be around for a while. So get out your X-ACTO, your CyA glue, and let's get started with building your own *Performance Phantom*.

Construction

Because this is not a model for a beginner, I will assume that the builder has reasonable building skills, particularly in the areas of glues and wood selection (light). Utmost care must be taken to ensure that the model is light, straight, and strong. A flat building surface is a must. The model will only fly as



Looking forward through the fan access hatch, you can see the rear of the completed intake. Note the circular tube in its center, an intake fairing which encloses the spinner on the fan. The purpose is to provide a totally smooth flow of air to the face of only the fan blades, for the maximum efficiency. This center section fairing is actually the rear part of the nose subassembly and is glued to the intake liner in the main fuselage.

good as it is built, so keep these things in mind at *all* times. Accuracy in your building will pay off in good flight characteristics.

Wing. the F-4 uses foam wing cores. There is no better way to ensure a light, straight wing than foam. Obviously, a wood wing for this model could get real complicated. I will not discuss foam wing building techniques as they have been published 100 times. I would, however, like to highlight a few things. For those who who are lazy, Robin's Wing (54 Sussex St., Newton, NJ 07860) has cores.

Call me an extremist, but I cut a lot of lightening holes in the foam. (Be sure to leave foam around the fuse bulkhead/spars F-5 and F-6). Less glue is necessary to adhere to balsa and there is plenty of strength left. If you are concerned about strength, sink a couple of carbon fiber or balsa spars into the foam but keep it light. I use Southern R/C Sorghum and 4-6 pound density sheet balsa.

At the polyhedral joint it may be wise to put a brace. Be careful of incidence changes and make sure both panels are identical. Check it with an incidence meter. You may think that this joint needs reinforcement (à la glass cloth etc.) Stress at this point is small compared to the root. Do make sure that you have good epoxy bonds and tight mating surfaces. I have put the F-4 through some punishing power on dives. The wing has not shown any signs of failure.

Do the retract mount and wheel-well whichever way suits you.

Pick your best servos for ailerons. I mount the servo in the end of the primary wing panel before attaching the outer panels. Be sure that you center the servo and offset the control arm forward about 10-15°. This will later yield correct differential throw for axial rolls. My servos are mounted semi-permanently. There is no access hatch. I knew that I was going to MonoKote the model so if I had to get to them, I would get out my trusty X-ACTO. Meanwhile, I save weight and hatch-seam induced drag. You decide if you want access hatches.

The only other item to address on the wing is the dog-toothed leading edge. The foam cores are cut and sheeted as one piece. Cut the outer wing panels loose and taper at 5°. Apply leading edges to all four panels and sand accordingly. The inner panels will remain symmetrical, but the outer panels should have the centerline lowered and sanded to a semi-symmetrical shape. It's not difficult, just take your time and be accurate. The benefit will be a docile airplane and slow landing speeds without the need for complicating flaps. There doesn't appear to be any negative effect at the other end of the flight envelope and it flies well inverted, too.

My wing panels, read to mount on the fuselage, including aileron servo, weighed 6½ ounces each.

Stab & fin. Cut stab cores and sheet with light balsa. Cut away the elevators and cap all edges. Do not join the stab halves at this time. It's done later during the alignment process.

The fin has three ribs. Cut them and make up sheeting. When assembling the fin, the two sides of balsa sheeting are pinched together at the leading and trailing edges, sandwiching the ribs. Be sure to keep this straight. Cut away rudder and cap. Set the stab and fin assemblies aside.

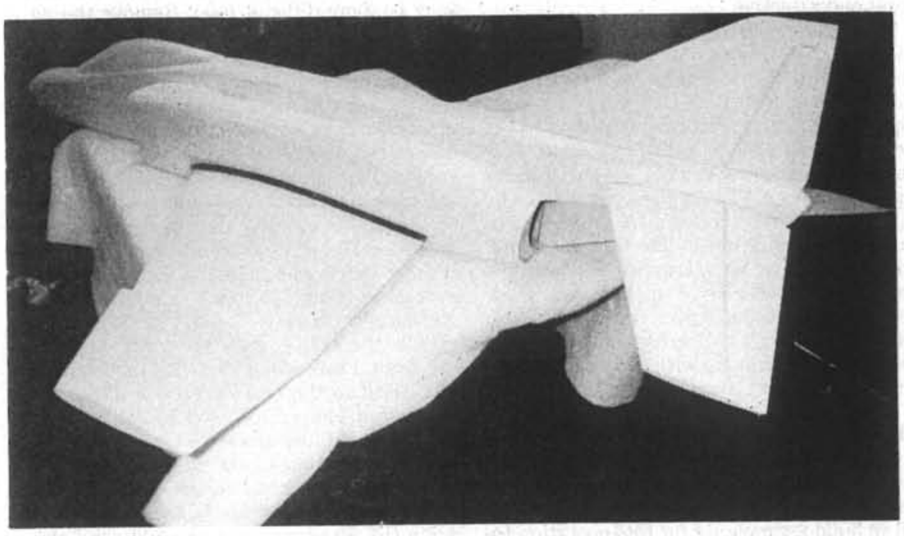
Fuselage. Starting with a flat building board, begin by gluing balsa sheeting to form the base. I use 1/8 light balsa. Draw a reference centerline to be used to align the bulkheads. Cut the bulkheads and drill F-2 for the nosegear. Drill a hole for the wiring harness and airlines in F-4 and F-5. Mount bulkheads F-1 through F-7 at their proper locations. Be accurate, especially on F-5 and F-6 which have wing spars. Delete F-3 (A&B) at this time. It will be involved in a sub-assembly later. Now, go back and laminate with epoxy pieces of 1/32 sheet (crossgrain) between each bulkhead. This will give a lock type construction and increase load transfer strength across the center. I sandwiched pieces of carbon fiber mat here at the same time.

Now is the time to figure out your basic radio installation. Lay in your wiring harness and air lines. You may have to dig a groove between F-3 and F-4 but keep it as flat as possible between these two. Since this is being built into the airplane, be sure to lay in one extra lead to be a spare.

Cut the main fuse sides and reinforce them with 1/64 ply. Cut lightening holes in the ply. Notch for wing spars, align with the bulkheads, and glue in place.

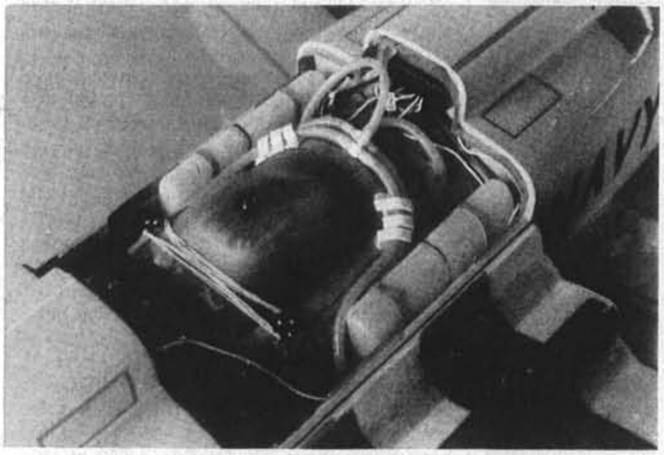
Take the fan shroud and tape 1/64 ply around the front of it (to temporarily simulate intake duct). Put the fan in the airplane, align, and glue the mounting rails. Drill mounts for G-32 bolts and blind nuts. Remove the temporary 1/64 ply liner. Carefully glue in F-3B (intake leading edge former) at proper cant and angels.

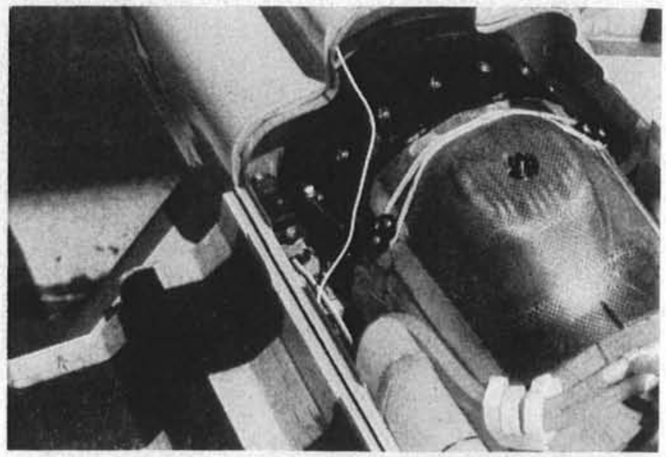
Cut two intake liners. Be sure that the grain of the 1/64 ply will wrap properly between F-3B and F-4. Make sure air lines and wiring come out through the gap that will be



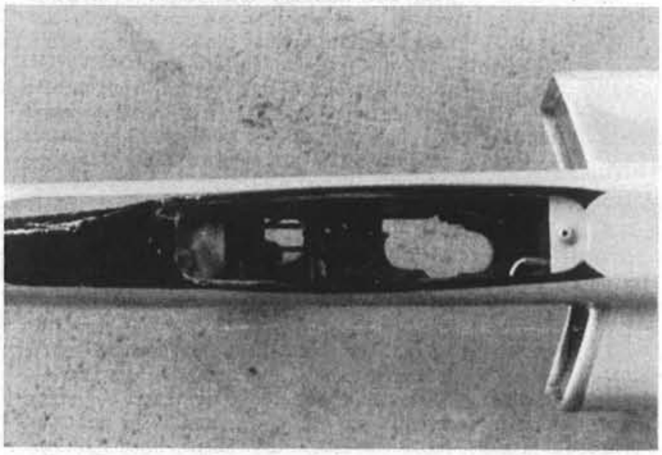
A single foam core panel is the basis of each wing half. Once sheeted, the panel is cut and bevelled at the polyhedral joint and glued back together. Maintain proper incidence! The completed *Phantom* airframe is an intelligent blend of many composite materials. Used only as needed in critical areas, each choice of material helps reconcile two often conflicting demands in high performance models, light weight and strength.

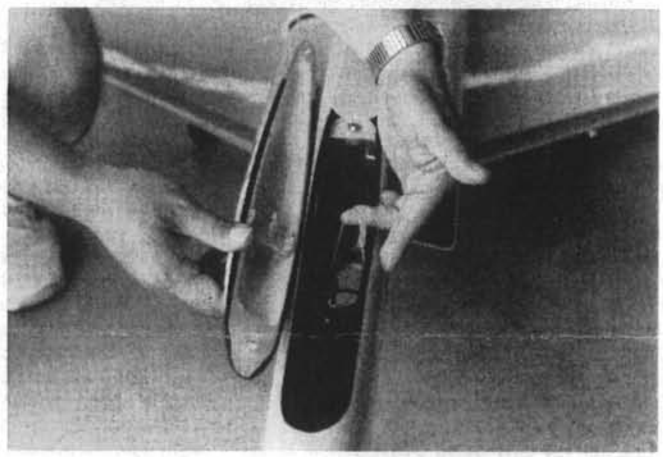
Performance Phantom





Bob Violett Models' saddle fuel tanks **(above left)** solved the fuel storage problem in the compact airframe. Neat fuel plumbing is an absolute must. Nested neatly behind and above the fan, in the bulkhead, is the receiver. Nested on the fan mounting rail **(above right),** the throttle servo has a straight run to the throttle arm. Popping the canopy off, gives you access **(below left)** to the air pressure tank refill valve plus the retract servo and the steering servo. "Low-tech" sometimes works just as well **(below right)** as with this rubber band canopy holddown arrangement on the *Phantom*.





F-3A. Trim liners as necessary, test fit to make sure that they fit well around fan and glue to F-3B and F-4 at bottom and sides. Leave the top open (sort of like a flap). You will have to spread this later to insert the front sub-assembly.

Nose subassembly. Cut fuse nose side pieces and 1/64 ply reinforcement. Laminate the ply to the balsa. The ply will extend beyond balsa and will for a "V" inside the duct. Epoxy glue the two exposed edges of 1/64 together. Be sure both halves are equal and share with the flat building board. Locate former F-3A and glue in place. Wrap 1/64 ply into the tube and reinforce the joint on the inside with a strip of 1/64. The tube should be the size of the spinner. Carefully locate spinner height and relieve "V'ed" fuse inner duct to accept the tube. Insert the tube, check alignment, and glue. Reinforce all inner surfaces of the V and tube with carbon fiber mat or glass cloth. Set aside for now.

Tailpipe

Cut 1/64 ply to rough size. It will be wrapped in and the seam joined with another strip (5/8 inch wide) of 1/64 ply. It may be helpful to build a simple jig for this operation to give you the proper taper. My jig consisted of two discs, one the size of the rear fan housing and the other the tailpipe exit diameter. They are aligned and fixed into position at the proper length and angle by spruce stringers. Wrap your 1/64 ply to form the tailpipe and join at the seam with another strip of 1/64. You may want to paint the inside of the tailpipe with K&B Superpoxy before this as it may be more difficult later. Remove the jig, trim, and fit it to end of fan unit. Try to get the tailpipe to "snug fit" the fan and come off as straight as possible.

Trim away the area for the engine. An engine cover cap can be obtained from the manufacturer of your fan and is used for engine access. Trim and fit onto the tailpipe. Build up the area around the cover cap with 1/64 ply to form a tongue and groove type of hold-down for the side and the rear of the cap. Rubber bands can hold the front tight. Be sure everything fits snug. We don't want pressure loss here.

Slide the tailpipe into the model through the front intakes back to the tail of main body. Bolt in the fan, align everything, and glue tailpipe into place. Now we are ready to go back and finish the intakes.

Spread the tops of the 1/64 ply liners and insert the entire nose sub-assembly. Mount the fan unit and trim this sub-assembly to fit. Align the entire nose sub-assembly and glue in place. Be sure the nose is straight with the rest of the fuse to alleviate yawing problems.

If you don't want to shaft start your fan or decide that the sub-assembly is too complicated, you may change it. The rear of the nose section sub-assembly can be built to "dome" inside the ducts. You will have to redesign the hatch to gain access for starting. The trade-off will be a minor performance loss.

Close up the top liners and reinforce the joint. Go back over the inner duct joints by running beads of microballoons and epoxy. Your end goal is to provide smooth, uninterrupted flow from the side of the airplane to the fan blades.

Now it's time to build the tail-boom. Cut the tail side pieces and laminate them with 1/64 ply reinforcement. Carefully make the stab cut-outs. With the top edges of the tail sideframes flat on the building board, locate and fit formers F-9 and F-10.

Go back to the main fuse and locate F-8 on the tailpipe at the proper angle. Use a straightedge to align it with rest of b :k-heads and top. Glue in place.

Take the tail section and set it in plac the fuselage. Carefully align the tail us straightedge to make sure it is squar flat on top. A piece of string stretched down the centerline of exposed top bulkheads will help bring tail into alignment. Glue in place.

The bottom dorsal fin can be fitted now. Be sure it is straight and will not cause air deflection. With the addition of this piece, the tail should become rigid.

Now back to the tailpipe. Because the tailpipe tapers so quickly from the back of the fan, the stinger of the tuned pipe will be at or just beyond the exit. To keep the tuned pipe from blocking off the exit area, you must build a "bubble" for the high point of the pipe to recess into. The length of the high point on my set-up is 12 inches. Cut a diamond shape out of the tailpipe, glue in the tailpipe brace, and reline the area with two pieces of 1/64 ply. Reinforce with carbon mat or glass cloth. Sand inside surfaces so that they are smooth and flowing.

Back to the nose. Finish attaching blocks, sides, and any triangle remaining. Carve and sand to shape. Carve the canopy from block balsa. After everything is carved and sanded, pop off the blocks and hollow inside. Re-glue and finalize the outside shape.

Glue 3/4 triangle and 1/4 × 2 inch sheet balsa to top of sides of hatch area. Rough carve to shape. Strip plank, with 1/8 inch balsa, the top corners of the intakes. Strip plank the top and bottom corners of the tailpipe area. It may be necessary to make up false bulkheads to get the proper contours. Don't be afraid of strip planking, it's a lot easier than you think. If you're still afraid, you can do this with balsa blocks but I personally think that blocks would be more work.

Now its time to attach the flying surface. Plug in the wing panels and set on a flat surface. Be sure that both panels are the same distance from the surface, the tips are equidistant form the tail's centerline, and that both panels are setting at the same incidence. Make whatever adjustments necessary now. Pull the panels off, mix 30 minutes epoxy, coat the spars and exposed foam. Plug panels back on and recheck your alignment. This is it, so do it right!

When cured, take your stab halves and insert one half through one side of the tail boom. Place in joining spars and insert the other half.

Rough check all measurements and make sure that the stab can be shimmed to a perfect alignment. Make sure that the tips are equidistant to the nose center, that both halves have the same incidence, that the incidence is the same as the wing (which should be 0). Now stand back and take a good look to make sure that the stab tips look even with the wing. When you feel *all* is correct, remove the stab. Mix 30 minute epoxy and repeat your assembly and alignment. Do it right as it will surely affect the way that the model flies. After all the cussing has stopped, reinforce the center section with carbon mat or glass cloth.

Now mount your elevator and rudder servo in the cavity ahead of F-8. Use long drill bits to drill holes for pushrods. I use solid wire pushrods in red Nyrod sleeves. This works well.

Again you must decide if you need access to those servos. I chose not to make access hatches for the same reason as the aileron servos. When you are satisfied with the pushrod arrangement, attach the 1/4 inch top deck.

Now it's time to attach the fin and rudder. I use the rudder hinge post to lock into the 1/4 inch top deck. Align and glue the fin into place and then attach the tail blocks.

Get out your three inch long X-ACTO blade and whittle off the edges of the top deck. A small block with 60 grit sandpaper will knock this down quickly. Rough sand all edges and get contours. Go finer in sandpaper grit to 100, then 150, then 220, then 320. I know that you're tired of sanding by now so take a breather. Come back later and take a good look at what you have. You should be pleased because it's starting to look like an F-4!

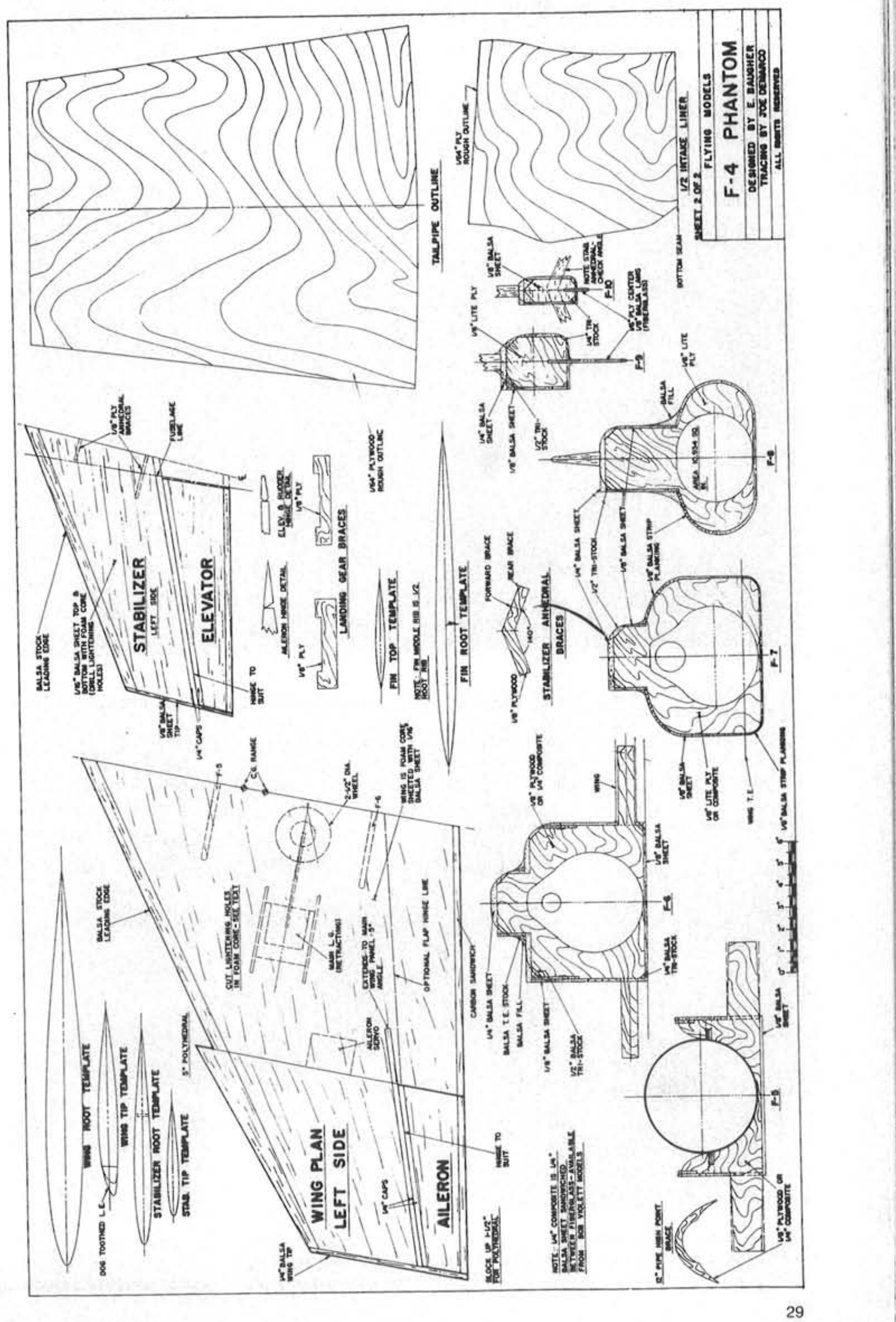
Use your favorite filler to take care of cracks and dings (I use spackling).

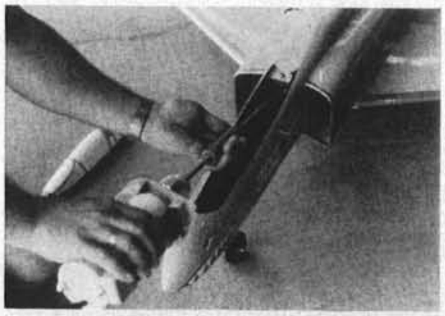
I was a little concerned about the wing-fuselage joint, so I went back and ran a strip of carbon mat topped with 3/4 ounce cloth around the joint. It has shown no signs of stress or weakening.

Cut your access hatch out and line the fuse edges with 1/64 ply. You can decide how you want to batten down the hatch (bolts, camlocks, spring pins, etc.)

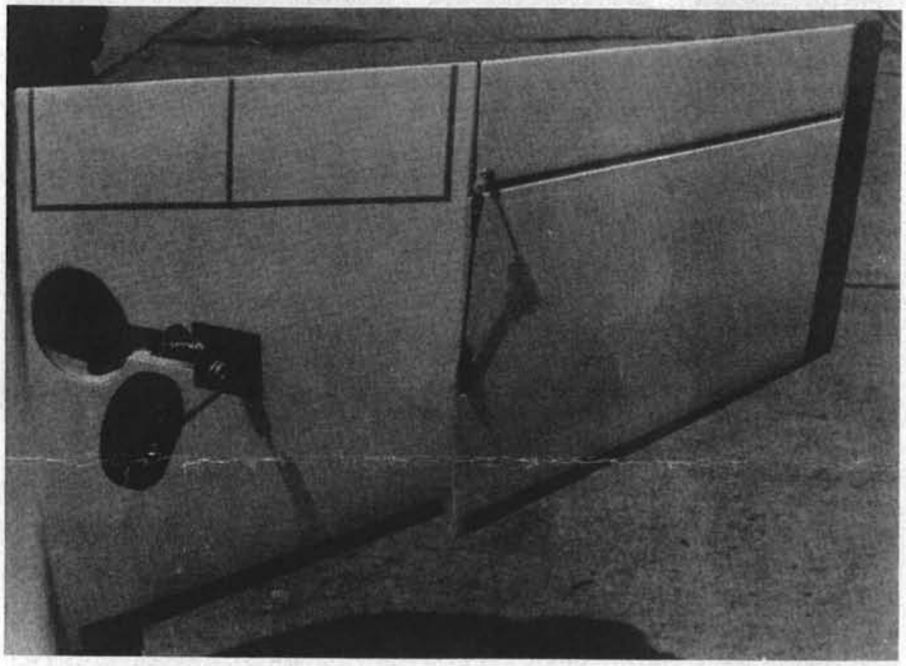
Now remove and clean up your fan. It may be necessary to slice the top portion of the tailpipe to get it out. Don't worry about doing this as the reinforced joint, when put back together with 1/64 ply strips, will be stronger than the original configuration.

Paint your intakes and, if you haven't done so, your tailpipe. Use only fuelproof paint!





With the fan spinner enclosed, Eric had to resort to a shaft starting technique **(above left).** The end of the starting wand has a ball hex head on it which engages a hex head bolt in the spinner to turn the engine. The hex head bolt in the spinner substitutes for the regular machine head Dynamax screw. The tuned pipe stinger **(above right)** is attached to one or the other side of the Magnalite keel. Since Eric MonoKoted the wing, he chose to simply cover over the aileron servo bays **(below).** A sharp X-ACTO knife gives access.



Finish the model with your favorite method. I use MonoKote since it is quick, light, and easy to work with. Whatever you do, keep it light!

Reinstall retracts, fan, tanks, and finalize your mechanics. I use a separate nosegear steering servo because the tolerances between F-3 and F-6 are very tight (minimal frontal area). Looping a cable through and around here would cause a sloppy set-up. Retract valve, servo, and air tank are all in the nose under the canopy.

Balance the model with the gear down and tanks empty. With model balanced and all controls working properly, you are ready to blaze the skies with your new F-4 *Phantom.*

Flying

The fruits of your labor will now shine. The *Phantom* will immediately attract crowds. They will be amazed with its performance. Don't let them distract you from rechecking everything.

Run up the engine. When you are satisfied that all is right, then it's time to fly!

My first flight was an exhilarating experience. The calculated C.G. did not account for fuselage lift and the model was severely tailheavy. Total pitch instability describes it best. How I go it on the ground, I don't know. The F-4 did survive, however, unscratched. Lead was added to the nose and the second attempt was made, this time with totally different results.

The model jumped off the ground (a grass field) in about 75-80 feet and quickly gained altitude. A couple of clicks of up trim were necessary, but none on aileron. This time everything felt good. It was time to ring it out.

The F-4 did everything I wanted it to with ease. A series of four point and eight point rolls were made. The model appeared to have blazing speed, but I was flying too high to tell. A low high speed pass came next. Heard in the background were exclamations of awe. It was true, the F-4 was fast.

The next thing to determine was the vertical. I pulled it vertical and it practically went out of sight! Top end performance was incredible.

How would it handle on landing? That question came soon enough as I was so captured by the performance that I ran out of gas. Would it glide or would the ducts become air brakes? The model didn't bleed off speed as quick as I thought it would. I flew it through a normal pattern approach and a beautiful landing followed. I did overshoot a little but the proof of low end performance was shown as the model remained docile and controllable all the way down. All in all, the airplane flew as well as any hot pattern airplane.

A round of applause followed. I went home, a very happy man.

This project has been the most rewarding since I first learned how to fly. I hope it will be as thrilling for you too.

I would like to take the opportunity to thank friend Jeff Hickam for his technical and moral support. I would also like to thank fellow club members Louis Levine and Neil Obert for their support in this effort. Finally thanks go to my wife, Susan, for her added encouragement.

The jet age is here! Take a step into the future of model aviation!