A fly-by. Bob attempts to position the model in same flight attitude as full scale BD-VI printed at right. Pilot's head behind the cabin post.

BD-VI

Little known, but Bede's unique single place machine is a superb R/C Stand-Off Scale project.

by Bob Aberle

I'm sure most model builders by now are familiar with Mr. Jim Bede and the achievements of his Bede Aircraft Corporation. Jim's original "BD-1," later became the popular American Aviation, "Yankee". That particular model is still being offered by the Grumman American Aviation Corp.

Back in the late 1960's Bede Aircraft directed their attention to the design of a new high wing, four place configuration which they designated the "BD-IV." This design is offered in full kit or semi-kit versions for the homebuilder. Many of these planes have been built and flown over the past couple of years. In 1973, at the EAA annual "Fly-In," Bede Aircraft unveiled their single place version of the "BD-IV," designated "BD-VI." The prototype made its first flight shortly after that show and was quite successful. Due to the tremendous interest in their radical "BD-V" design, both piston and jet versions, most of Bede's resources during the past year or so have been directed exclusively towards that project. The result being that the little "BD-VI" prototype, up until recently, was a one-of-a-kind airplane. At this writing it is my understanding that final plans are being prepared and homebuilder's kits are in the works.

About The Full Size Bird

When one studies the "Bede-VI" three view you get the immediate impression that it is very small. The wing span is only 21 feet and the chord (if you believe it!) is only 2.58 feet. That's only a little more than 50 square feet of wing area. The basic power plant for this little bird is a 55 hp. Hirth two cycle, two cylinder engine. The German made engine was first used by Bede on their now famous "BD-V" (propeller driven version). Performance specification indicates a cruise speed of 140 mph, a climb rate of 900 fpm and a respectable service ceiling of 14,000 feet. Not bad for such a small plane! Wing constuction is the tubular aluminum spar with the slip-on rib modules as originally pioneered by Jim Bede on the "BD-I." By the way, this plane is all aluminum. No fabric covering is employed. Certainly the modern way to go.

A Few Words on the Model

The straight, rectangular shaped fuselage sides and the constant chord wing lend themselves to an easy scale project. Since the trend recently has been towards smaller R/C models it was decided to try a .20 powered version using a wing area of 375 square inches. The exact scale factor used was 2.6 inches equals 1 foot. Remember, with today's modern digital pocket calculators you can easily use any scale

Photos by the Author

factor you want. My model has a 56" wingspan and ended up weighing 4 lbs. 3 ozs. or 67 oz. This works out to a moderately heavy wing loading of 24.6 oz./sq. ft. The wing section chosen is almost exactly the same as that used on the full scale aircraft, which I believe to be an NACA 2413. Horizontal stabilizer area was increased by a couple of percent just to be on the safe side. With the generous nose moment arm, and the forward C.G. location, I'm sure you could make the stab exact scale. Vertical fin area, on my model, was slightly larger than shown on the original company three view. In a recent discussion with Mr. Frank Andrews of Bede Aircraft I learned that the vertical tail on the prototype had been increased somewhat. When I received a revised three view from Bede's Chief Designer, Mr. Paul Griffin. I was surprised to find it very close to the size and shape I had already chosen on my model. I must admit also that I reduced the fuselage length by approx. ½" so that standard 36" balsa could be used. Yes, economy does have to enter into the design at times. The spinner chosen (2¼" dia.) was considerably smaller than scale. In fact the closest size to scale would have been a Fox "Slim Jim" 2¾" dia. I just felt that a spinner that big would have loaded down the little OS Max .20 too much. Also the Fox spinner would have to be primed and then spray painted white. The plastic 2¼" dia. spinner was an easier choice.

It was originally intended to make this project for a multi-purpose application. I wanted a training version with basic rudder, elevator and throttle control, along with a wing containing 5 degrees of dihedral. This would be followed by a flat wing with ailerons. Progressing further, the modeler could fly the plane as a stand-off scale. Or finally, an exact scale version could be built with a detailed cockpit and functional windows. After concluding this project, however, I feel that it is definitely not a beginner's airplane. Its handling characteristics are quite good, but surprisingly, a considerable amount of man-hours were required to build such items as the cowl and the special nose gear arrangement. I would therefore recommend this model for only Stand-Off or Scale applications.

Construction

As usual I start with the wing. I still favor built up wings and prefer to build them using the simple two wire wing jig system pioneered by Joe Bridi. This particular wing, less covering, weighed only 6 ounces and yet was extremely strong. I suspect a foam wing of comparable strength would have weighed at least twice as much. I cut the ribs in a stack or sandwich using a plywood template on each end. The stack is bolted together using 8-32 hardware. These same holes (No. 21 drill) will provide a good fit for the 5/32" dia. wing jig wires. Make sure you use spruce spars as indicated on the plans. I built each wing half on the jig wires. The top 1/16" wing sheeting was glued into place before lifting the frame off the building board, then each panel was "flipped" over with the jig wire relocated on the building board. It was at this point that I decided to add some wash-out at the wing tip to improve the low speed flying characteristics. I actually shimmed up one of the jig wires just enough to cause about 1/8" wash-out at the wing tip (trailing edge elevated 1/8"). Once set in position I applied the bottom 1/16" sheeting. The application of the sheeting actually locks the wash-out in position. Next step is to join both panels using the plywood dihedral braces indicated on the plans. The ½" of dihedral is just enough to prevent the appearance of a sagging wing. It ends up looking flat. Use epoxy glue at this joint.

To really add strength to this high aspect ratio I placed vertical grain 1/16" balsa webs between each rib at the main spar and at the termination of the trailing edge sheeting. Don't omit this step, it is most important. This is especially true if you later use a plastic film covering.

Add the balsa block pieces in the center-section to support the wing hold-down bolts. Complete the wing by adding the center sheeting and capstrips. The wing tips are carved from solid balsa. The ailerons are just ordinary ¾" x 3/16" trailing edge stock. Select medium to hard balsa for this application to prevent aileron flutter or buffeting in flight. Four hinges are recommended on each aileron.

Next major item of construction is the fuselage. Each side is constructed from two butt jointed 3/32" x 4" x 36" sheets of medium weight balsa. Actually the fuselage side is a little higher than 8", so an additional strip also has to be added to obtain the correct dimension. If you notice I chose to use only a partial 1/16" plywood doubler around the wing seat. The usual full depth doubler, from the trailing edge of the wing forward to the firewall would have necessitated the purchase of some $5.00 or more of model grade plywood. The tendency today, with modern digital flight controls, is to land a lot softer (most of the time!). A good deal of our present models are still overdesigned from a stress standpoint. Be sure to add the spruce stiffeners to the fuselage as shown.

While both sides are drying, cut out all the plywood formers. The assembly of this large "boxy" fuselage is quite easy, requiring no special jigs or holding fixtures. I placed one side flat on the building board (a good straight surface). All the plywood formers were glued to the one side using Hobbypoxy Formula IV quick drying cement. Each former was braced with small triangles to maintain their position perpendicular to the one side. Within minutes I placed the other side down on top of the protruding formers. Again the quick drying cement was used. After drying I simply pulled the sides together at the rear, checked the overall alignment (strictly eyeball) and applied the cement. You will probably notice on the full size plane the fuselage sides bend in abruptly just past the wing trailing edge. The model plans show this sharp joint, however, in practice I actually allowed a gradual taper to the rear. I didn't want to crack and re-glue the sides which would have weakened the entire structure.

Now you have something that looks like a giant fuselage. Don't get worried, it will eventually fly. Add the top 3/32" balsa sheeting with the grain running diagonally. Up at the nose section you must add the 3/8"x½" maple engine bearers. Drill the clearance hole at this time, in F-1, for the throttle Gold N'Rod. In fact you can install the outer sleeve of that rod at this time. The rear portion is glued to the under side of former F-4. Add the 3/32" sheeting in the area of the front windshield.

At this point we have enough of the fuselage completed so that the wing hold-down system can be installed. First glue the 3/8"x½" hardware blocks in place with epoxy glue. This is actually leftover engine bearer material. Temporaily place some 1/16" thick foam rubber wing seating tape on the wing saddle. Hold the wing in place and proceed to drill four holes using a #21 drill bit. Drill completely through the wing and on through the hardwood blocks underneath. Please note that the drilling is done perpendicular to the fuselage reference line or datum line. With this arrangement the nylon bolts will mount straight down. If the wing bolts were mounted flush with the airfoil shape they would enter the fuselage at an angle.

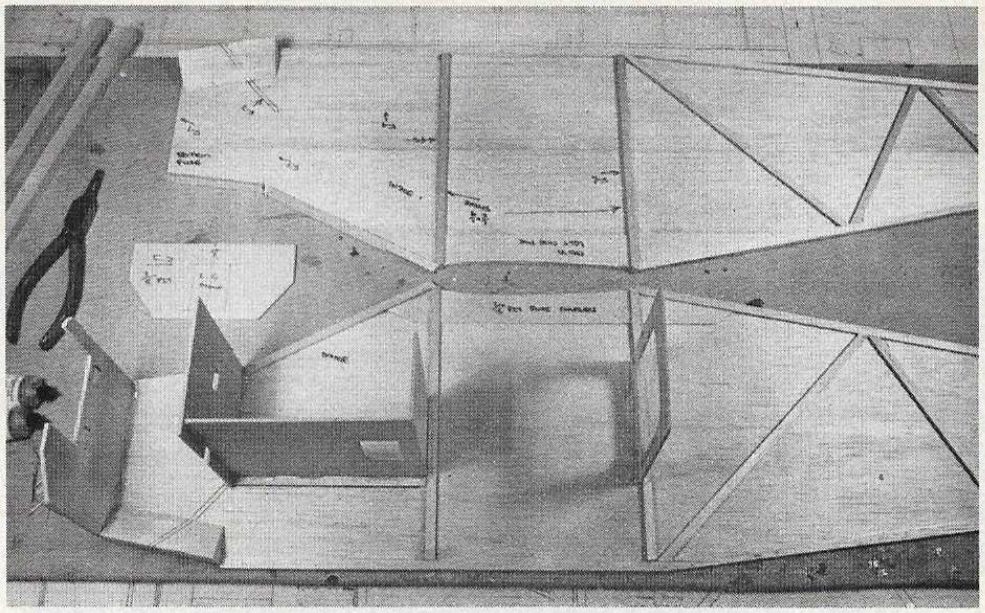
This angle would create problems with the wing incidence, so please follow my directions. Remove the wing and tap the four hardwood blocks for a 10-32 thread. Drill clearance holes in the wing using a #10 drill. I also added small 1/32" plywood reinforcement discs, on top of the wing, under each nylon bolt head. This will prevent the bolts from eventually pulling through the wing.

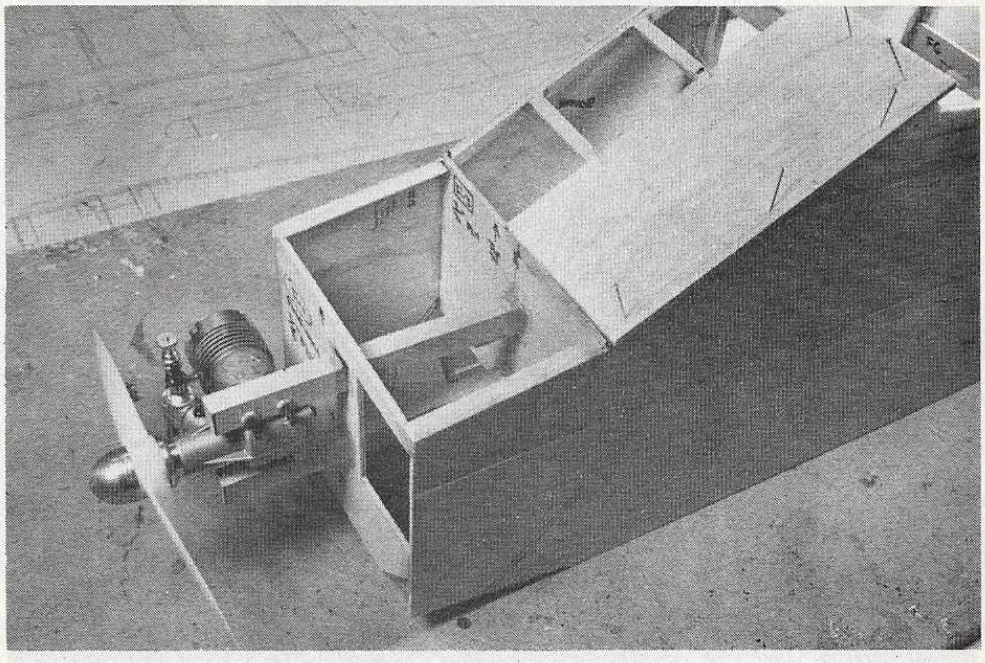
Attach the wing to the fuselage now, using the nylon bolts. Cut out the horizontal and vertical tail pieces from 3/16" balsa. Note the grain indicated on the plans. Don't forget that spruce spar in the vertical fin. Sand all surfaces and pre-install the elevator and rudder hinges. If you are doing a full scale project you will have to consider an all flying stabilator, instead of the elevators I used. Install the fin and horizontal stab in position. Use epoxy glue liberally. When dry I added Sig Epoxilite fillets to both the stab and fin joints. With the bottom of the fuselage still exposed I like to prefit my control linkages. Epoxy two servo rails as shown. My R/C equipment consisted of a 1969 Kraft four channel system using KPS-10 servos. The rudder, throttle and elevator servos were mounted in a Kraft servo tray (all three side by side). Sullivan Gold N'Rods (red color) were run out to the elevator and rudder. The elevator is especially convenient since the control rod comes directly out the back end of the fuselage. I usually fire up the radio and make sure everything is in working order, without any control surface binding. It's a lot easier to trouble shoot at this time.

Now let's talk about the nose gear linkage for a moment. To make this plane look even close to scale you must have that nose gear slope forward at the angle shown. I believe that the photographs will explain this hook-up. The only additional item required is the 90 degree bellcrank. The gear itself was bent from a DuBro wire gear (5/32" dia. wire with the coil in the center). Only two bends are required. Although this arrangement worked out well it does have a few drawbacks. It unfortunately puts a little extra load on the rudder servo gears. I would definitely put my poorest servo in this particular position. The alternative might be to use a DuBro or Rocket City over-ride device to help absorb some of the wheel motion vibration which is transmitted directly to the servo. The other problem noted is that the motion of the nose gear tends to make the entire plane "wiggle" a little when it is being steered. On the full size plane the nose gear is a free swivelling type. Steering is accomplished by alternately applying brakes to the main landing gear wheels. To do this on a model would be quite a job.

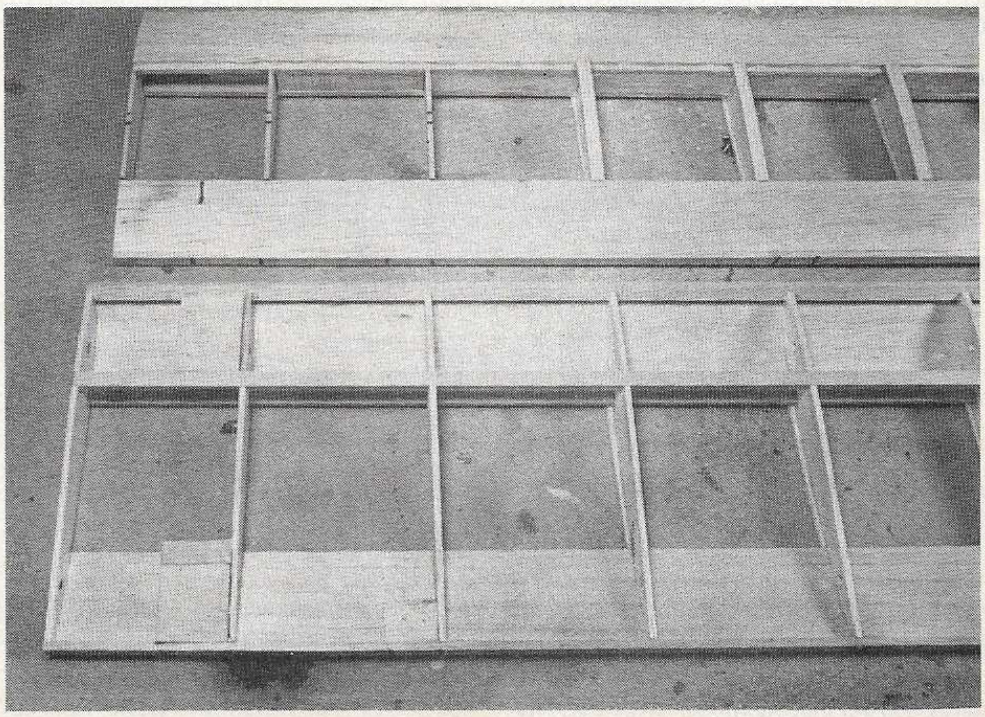
As the final touch of scale realism you might want to add a small fairing to the nose gear strut. This is shown on the plans as an option. You could fabricate this fairing from either sheet aluminum or 1/32" plywood. Because my flying field is quite rough I chose not to bother with the fairing on my model.

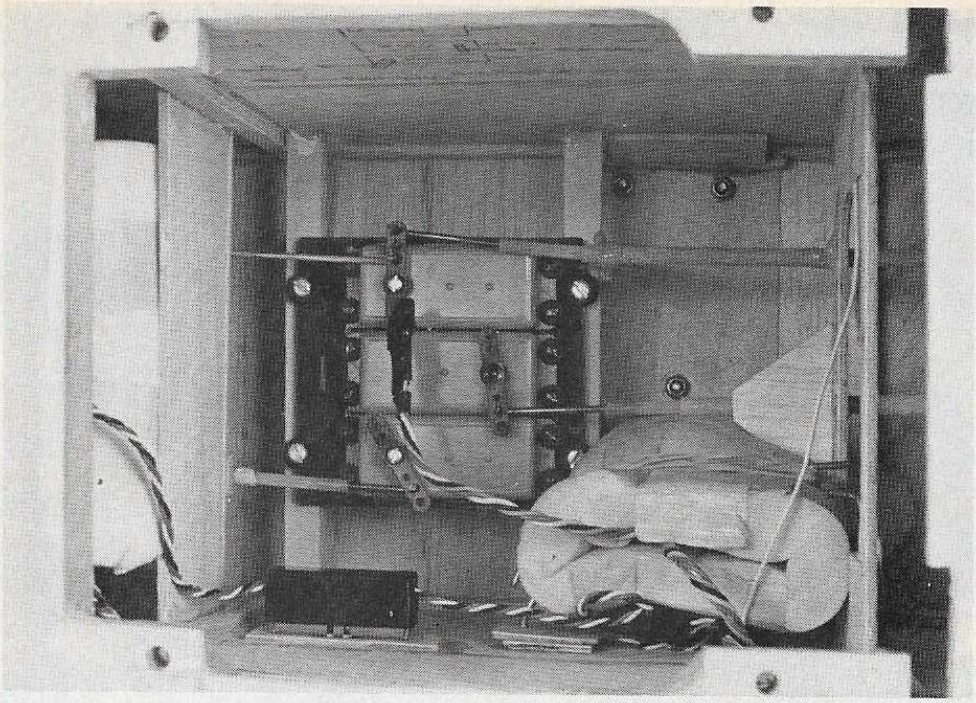
Once the nose gear is hooked up and working you may proceed to sheet the fuselage bottom with 3/32" balsa. Epoxy the 3/32" plywood main landing gear mount in position. The main landing gear was made from T-6 (hard) aluminum. The plans show the pattern for cutting out the material.

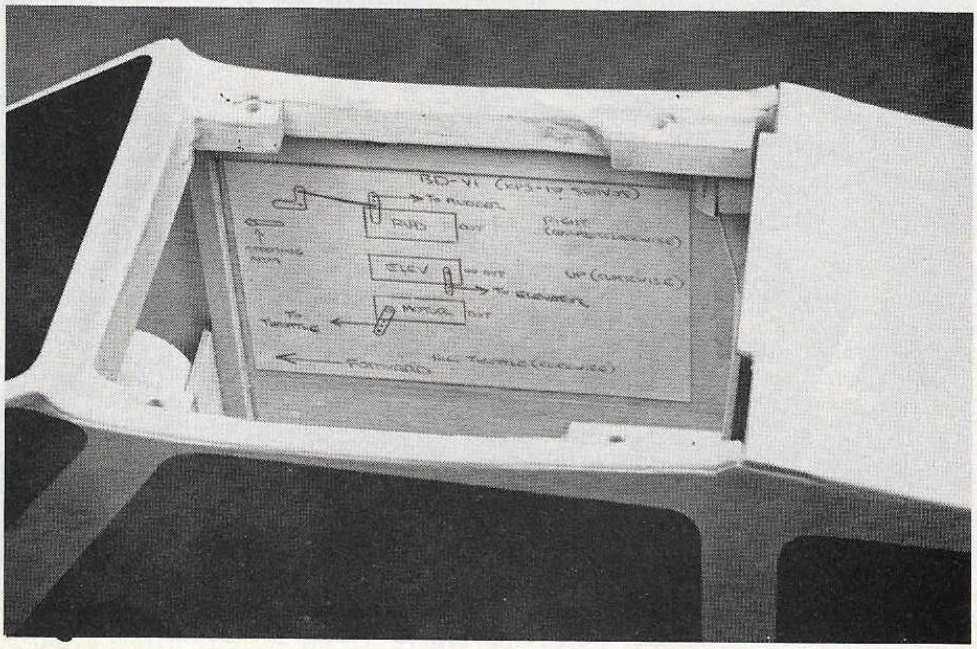




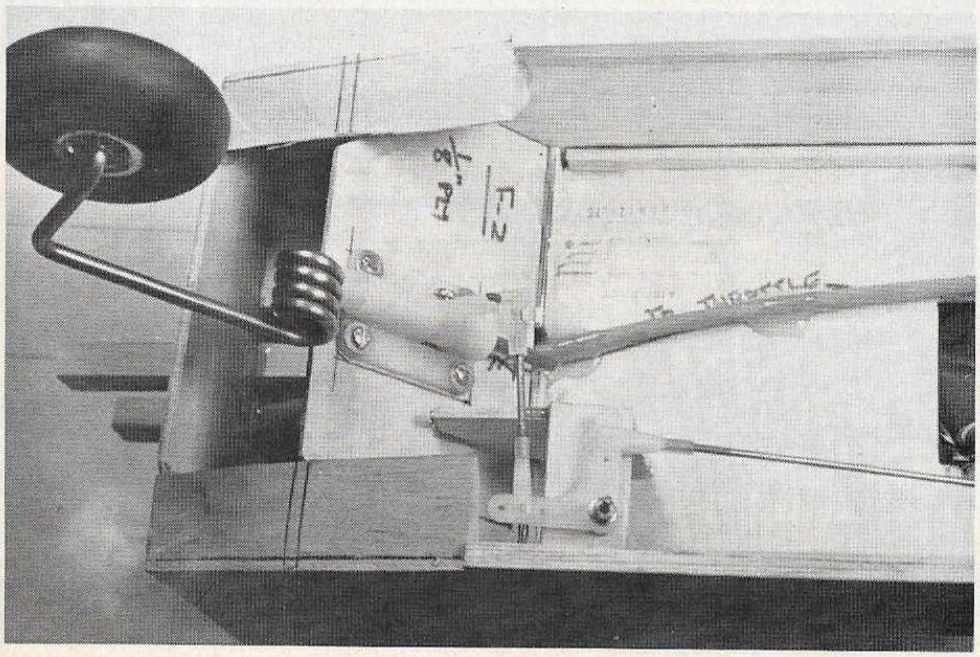
An OS Max .20 temporarily installed. Note the cut-out for the fuel tank and proximity to engine. **At top:** The start of the fuselage assembly. Big boxy type structure, very easy to put together. **Beneath:** Wing construction is shown here. Don't forget the 1/16" sheet webbing between the ribs.







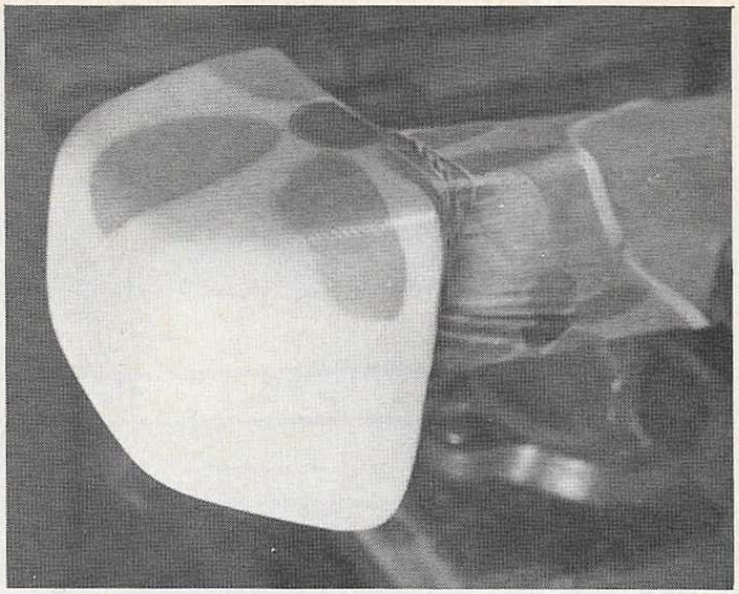
Graffiti? Not quite, a home-drawn internal cabin diagram, thou shalt not forget switching radios. **At top:** Note radio compartment. Receiver at lower right, three servos, battery pack at far left. **Below:** Bob achieved nose wheel steering with 90 degree bellcrank, retaining scale angle of gear.



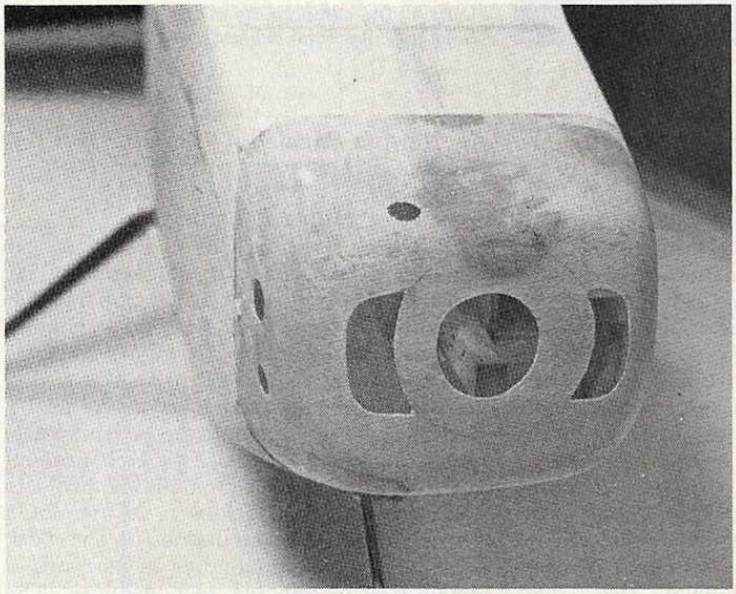
As an alternate you could use a Sig landing gear blank. Either way make sure you use a generous bending radius of at least ¾", otherwise this very hard material will easily crack. Unfortunately my favorite Hallco landing gear could not be used in this particular scale application.

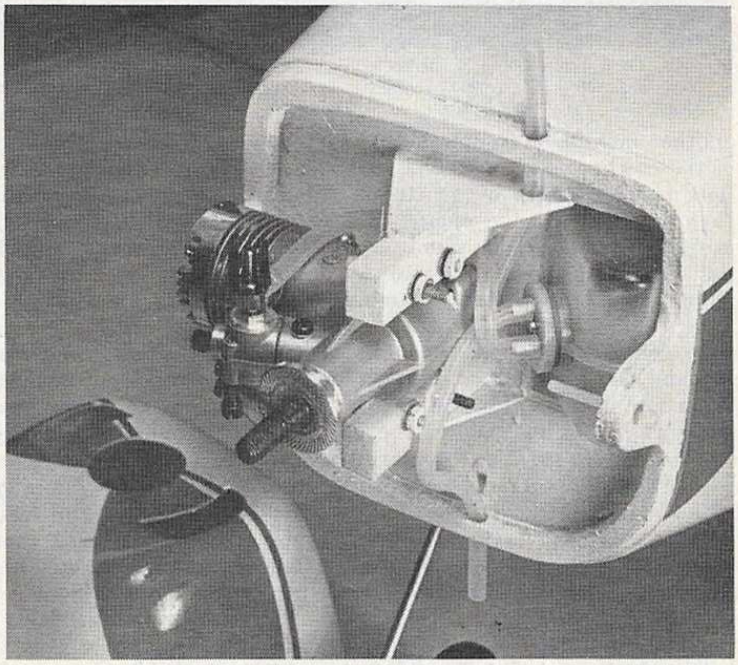
The last remaining item of construction is the molded cowl. I decided to try the Hobbypoxy balloon method which has been popular for many years. A complete instruction sheet on this method can be obtained by writing to Mr. Bob Pettit, Hobbypoxy Division, Pettit Paint Co., 36 Pine Street, Borough of Rockaway, New Jersey 07866. For my particular application I made up a mold from a very dense piece of styrofoam. Just prior to working the styrofoam I cut out former F-1A, using ¼" plywood. The best way to do this is to hold an oversized piece of ¼" ply directly over the firewall F-1. You wil have to cut a temporary clearance hole for the beam engine mounts, then trace a pencil line on to the plywood marking the location of the firewall outline. Before cutting this F-1A former you must draw another line which is 1/16", all around, less in size than the firewall outline. Now cut F1-A out to this new line. The 1/16" clearance provided will eventually handle the thickness of the model cowl, making it flush with the fuselage sides. I lightly spot-glued F1-A to the foam block. After marking out the the top and side profiles. I cut the foam to the approximate size using a hand jig saw (a hot wire would probably be better). The actual shaping was done with #40 production grade sandpaper with the finishing touches obtained using #150 and #220 grade paper. Remember you must sand the foam down so that it is flush, all around with the former F-1A. Next remove F-1A and put it aside, then use your Dremel tool and gouge out enough foam so that a piece of 2"x3" can be glued into position. The 2"x3" will provide a sturdy support during the molding process. When dry, clamp the 2"x3" into a vise and x lace a large piece of Saran Wrap over the entire foam mold. I would suggest you spray the Saran Wrap with some type of mold release. I was never able to remove all the wrap. As a result I couldn't paint the inside of the finished cowl. Cover the entire mold area with a piece of Hobbypoxy Easy-Does-It cloth. Mix up a batch of Hobbypoxy Formula II glue and apply it liberally over the cloth. Use a stiff brush as an applicator. Next (and most important) place a piece of Midwest 6/10 ounce fibreglass cloth directly over the Hobbypoxy cloth. My experience indicated that the single layer of Hobbypoxy cloth was not strong enough. Apply some more Formula II glue over the second layer of cloth. Now comes the crucial part of the job. Inflate a *large* balloon almost completely. Then, while holding the air inlet portion of the balloon start pushing it over the mold while letting air out at the same time. The idea is to completely envelop the balloon around the mold. The pressure of the balloon will smooth out the fibreglass, yielding a neat final product. Let this all dry overnight. The next day you cut away the balloon and with the help of a Dremel tool, remove the cowl from the mold.

Referring back to the plywood former F-1A, cut out the center portion so that



All the ingredients to make a Hobbypoxy Easy-Does-It type cowling. Note styrofoam mold at left mounted on a common 2x3. Former F-1A in center. **Right:** Balloon in place covering the complete mold. Remove it tomorrow.





A Dremel tool neatly cuts out cooling, access holes required in cowling. Right: Fuel tank well forward for balance, perfectly positioned in cowl.

only about ¼" remains all around. Epoxy this former directly to the firewall, F-1, leaving equal spacing on all sides. When dry, you can attempt to fit the cowl in place. It will probably take a little grinding or sanding to make it fit. You can also temporarily mount the engine at this point and determine where the necessary cutouts must be made in the cowl. The Dremel tool will again come in handy for this operation. As you will notice in the photographs I held on my cowl with two small Prather Products, 4-40 nylon bolts. These bolts were threaded into a piece of plywood on one side and a piece of hardwood on the other. In fact the bolt, on one side actually projects far enough into the engine compartment so that it holds the fuel tank in position or at least limits its forward travel.

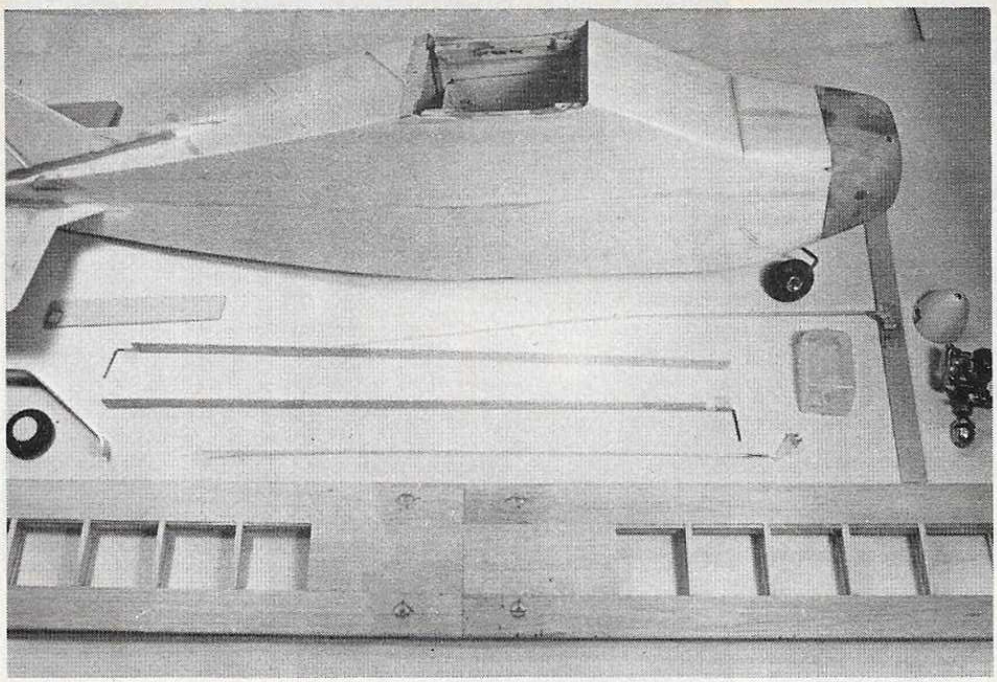
Covering and Finishing

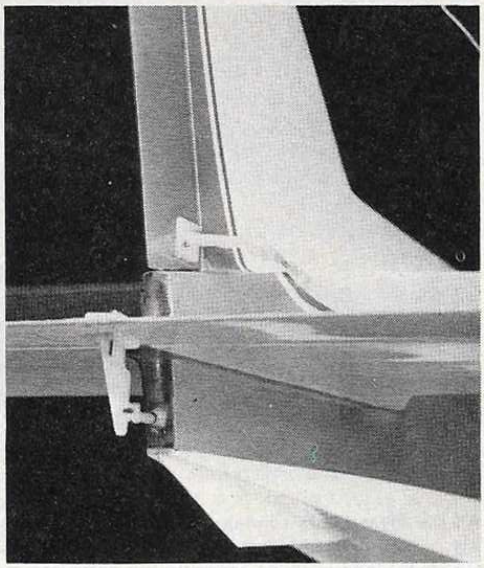
Let's first talk about the actual color scheme. According to Bede Aircraft, the prototype is essentially all white (polar white they call it). Along the fuselage side is a large band of orange (specifically Dodge Charger orange or fire orange). The final touch is a pin stripe just above the orange band from the nose all the way to the top of the vertical fin. This pin stripe is a dark "sable" brown. The interior colors, for those interested, are said to be orange and black.

I like to keep my color schemes as simple as possible. Since I knew I couldn't obtain a brown colored Bridi Quik-Stripe I decided to change the color scheme to that of the original "BD-IV" model. On this plane the fuselage band is red and the stripe is also red. Three excellent color shots of this "BD-IV" appeared on the cover of Air Progress, October, 1970.

On my model I chose a little bit of a hygrid finishing system. The wing, ailerons and elevators were covered with white, opaque Solarfilm. The Solarfilm white does not have the super high gloss that is a characteristic of MonoKote. As such it tends to match the epoxy painted surfaces better. The fuselage, cowl, landing gear, rudder and horizontal stabilizer were finished with Hobbypoxy products. This included two coats of clear followed by two coats of Hobbypox filler thinned 50 percent. After drying overnight this was wet sanded with #400 paper until most of the brown filler color was eliminated. One more coat of clear was applied. This was also wet sanded with #400 paper. two coats of Hobbypoxy filler thinned were sprayed on, allowing 24 hours between coats. After another day's delay I masked off the fuselage for the wide color band. This was sprayed with one coat of Hobbypoxy bright red. Pull all the masking tape off within an hour after spraying. Next day add the Bridi Quik-Stripe (⅛" red). All the windows were simulated using black trim MonoKote (regular type). The white license numbers and the "BD-VI" insignia were cut from white trim MonoKote.

The mounting of the OS Max .20 engine left several options open to me during the original design layout. Since the cowl is so large I decided to use the Tatone Exhaust Manifold instead of a muffler. With the side mounted engine, the exhaust port which comes out parallel to the cylinder head was selected. As supplied by Tatone all the three ports are covered. All you have to do is drill out the one of your choice. Tatone also supplies a black, hard rubber tube, which is supposed to be used as an exhaust extender. I found this material to be unsuitable as I needed about





Elevator hook-up exits directly out back of the fuselage. Plywood scale skid is very necessary. Left: All the components of the model ready for finishing. Its total weight was 4 lbs. 3 ozs.

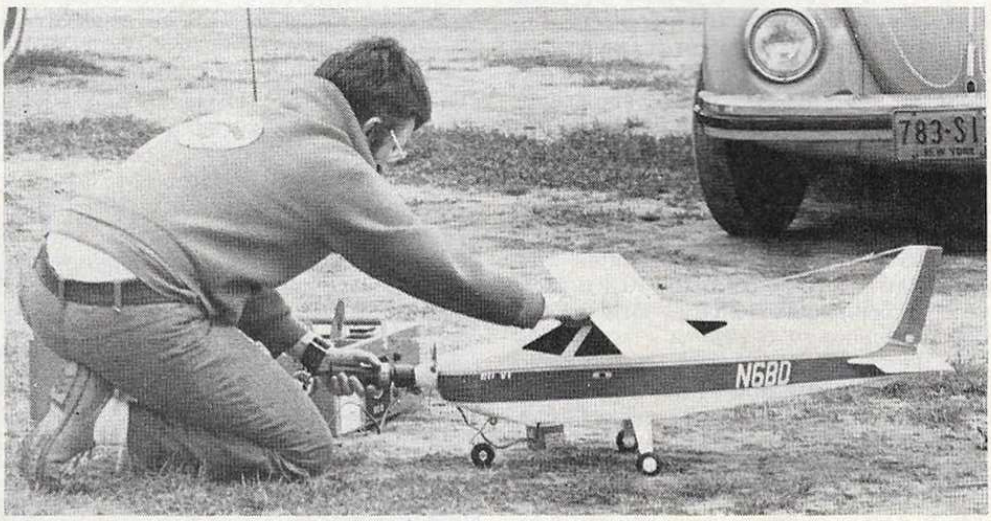
another inch or so to get the exhaust out of the cowling. Fortunately I was able to find a small length of 3/8" teflon tubing. As you will see in the photos this was attached with a tiny hose clamp. If you can't find a piece of teflon, try some thin-walled aluminum tubing. Select a diameter which will provide a snug fit on the manifold, then drill a small hole through the tubing and the manifold and insert a small sheet metal screw. I chose to exit my exhaust right out the side of the cowl, the most direct route. You could run a scale exhaust port out the bottom of the cowl, in front of nose gear. The only problem with this is that residual fuel can enter the clearance hole for the nose gear. This could eventually eat away the interior nose section.

When completed, my particular model balanced about 1/2" forward of the indicated center of gravity (C.G.). In other words it was slightly nose heavy. With a relatively small horizontal tail area I chose to fly it exactly that way. Initial flight testing has proved that the forward C.G. position works out quite well. Its a good idea to provide at least, plus/minus 3/8" of elevator travel, for your first flights. You can always reduce the throw later on. I must also say that the OS Max .20 and a 4 lb. 3 oz. plane ends up with rather slow performance, but it is still relaxing to fly. If you care for a faster plane there is no reason why you couldn't put a .29 or .35 in this same plane. With a heavier engine you could be wise to move the servos back towards the trailing edge of the wing. The receiver and battery pack could be mounted side by side directly on the C.G. Or in the case of a heavy engine installation, you might move the battery pack aft of the trailing edge. The particular wing area chosen should be able to handle total weights up to about 4 3/4 lbs. without difficulty. Beyond that limit you would probably have to "beef up" the main landing gear to at least .125" thick material.

If you are truly interested in an exact scale project I would suggest you write to Bede Aircraft for information package on the "BD-VI". This package cost $4.00 and includes such material as three views, photographs and an assortment of detailed data on the full scale plane. Their address is Newton Municipal Airport, Newton, Kansas, 67114.

Other Possibilities

How about a 1/2 scale version of the "BD-VI" with 10 1/2 foot wingspan and an area of approximately 2,000 sq. in. This could be powered by a Ross four cylinder, .120 cu. in. displacement engine. A truly spectacular scale project with the ability of carrying such payloads as movie or TV cameras. True, it would be quite costly, but it could be tackled as a club project. I haven't heard of club building projects for a long time. The idea is to appoint a Project Engineer who divides up the work load so that each member is assigned a small area of building responsibility. The P.E. supervises construction and assures that all the various parts can be properly integrated into a complete model. A project such as this can be quite rewarding. A resulting ten foot 1/2 scale R/C model would be some show-stopper at local flight demonstrations. It would tend to remove the annoying "toy plane" connotation so often associated with our hobby/sport. How about a big one fellows?



Bob applies a Kavan Starter. OS Max .20 proved adequate in power, other engines are possible. **Left:** Nick Ziroli on hand to do the first-flight thing. Nerves of iron, 'cause it's Bob's ship.