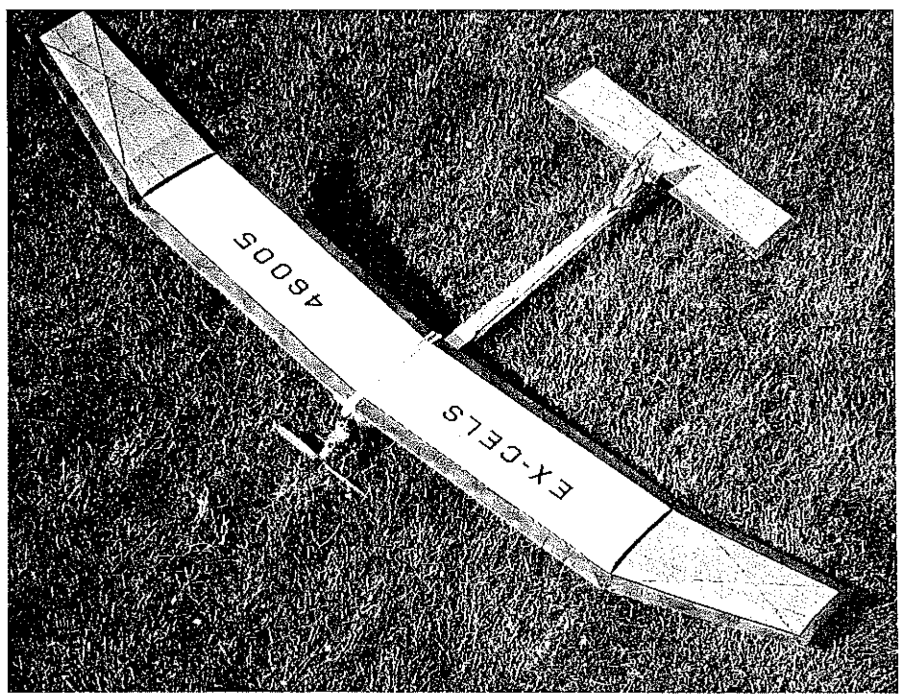
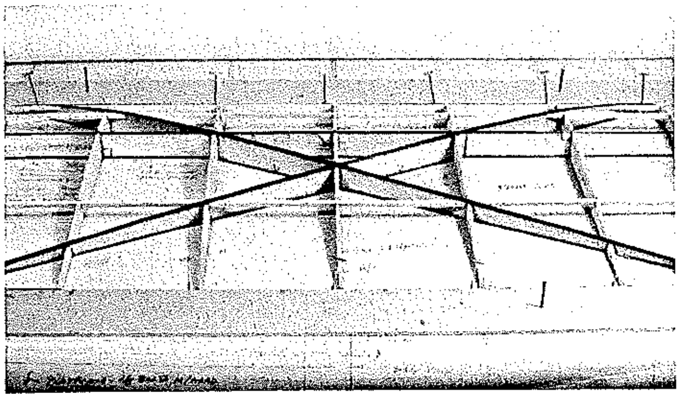
ex-cels 520

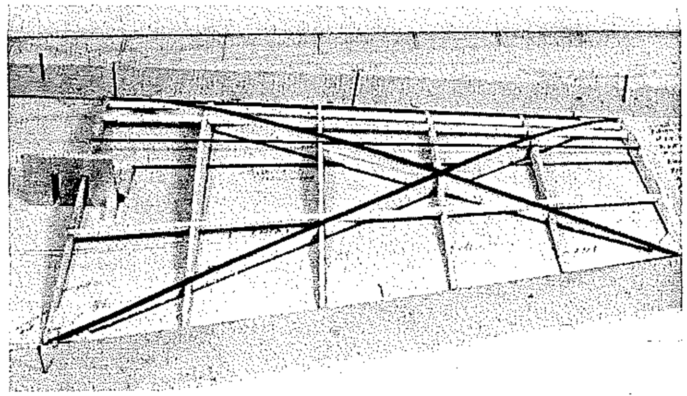
It's always been the type of construction plus the type of material used that determined the strength of a given structure. When both are as sophisticated as in this model, you have to expect superior results.

THE PUN in its name is no idle boast. The Ex-Cels is a high achiever indeed, a state-of-the-art model capable of meeting the challenge of the new Category III flyoff rules. Although it's named for the series of

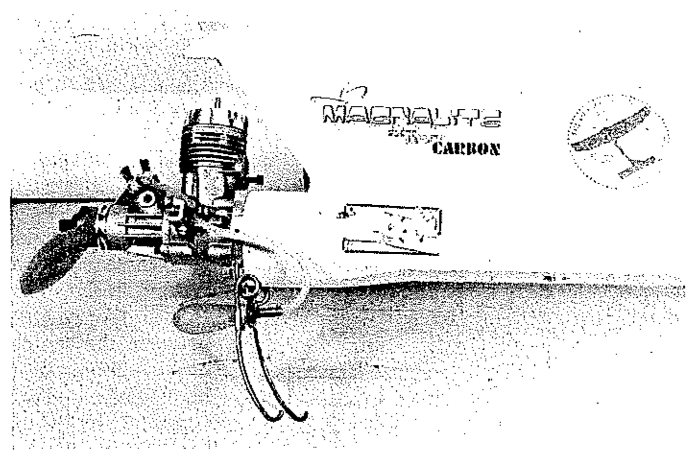


Top: The family portrait. They've all been successful too, capturing many wins in ½A, A-B, and C-D classes of Free Flight. Left: Our author prepares to fire up for the winning flight in the Class A event at the 1986 Nats, in Lake Charles. Right: To get the most out of the short engine runs allowed, it is imperative to get the weight as low as possible. That translates to *carbon fiber,* because little else on the market can match its strength for weight ratio.





Above: The main wing panel is pinned into position for the addition of the carbon fiber (C.F.) cap strips. Above right: The wing tip is blocked up in the warped position (1/16-in. washout) for gluing on the C.F. caps strips. Note the easy-does-it jig for installing the polyhedral rib at the correct angle. Right: The front end sports a very light Tomy timer to trips the fuel pinch-off unit that is located close to the venturi for trouble-free plumbing. The very attractive Magnalite logo is available from Bob Violett models.



carbon fiber X-cells glued together to form a light, strong, rigid structure, I like the implied salute to how it performs, too.

For my design I am indebted to Bob and Bill Hunter as well as to a number of others whose ideas I have used and elaborated upon. Parts of my finished Ex-Cels resemble their versions, and I couldn't have done it without them. However, a good second look will show that my Ex-Cels has undergone many evolutionary stages. Using very unorthodox construction methods and materials, I experimented until I was satisfied I'd made the necessary changes in design parameters to establish near-optimum performance.

Fin area was increased to control a wandering tendency on power. A variable incidence tail plane was added for optimum glide adjustment. The airfoil was changed to 9%, wing area was increased, wing taper was improved, and overall drag was reduced while still maintaining the actual lift characteristics of the wing. These changes, along with the ultra-light construction, have enhanced the glide.

Because of the reduced drag and lighter weight of the model, the altitude gained on power has been improved. The ultra-light tail feathers have made it feasible to lengthen the tail moment, while the nose has been shortened, adding stability on power.

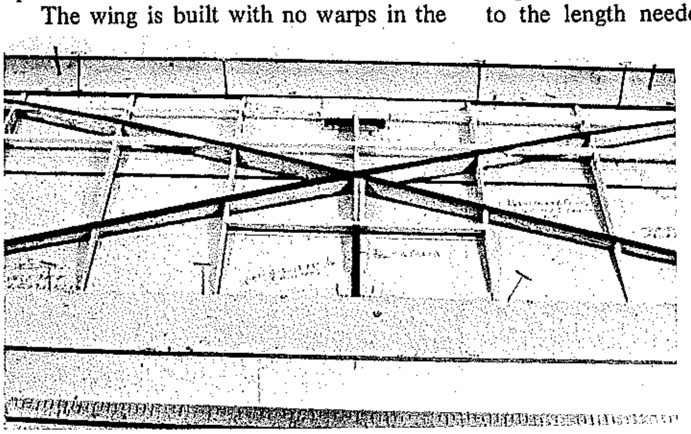
The wing is built with no warps in the main panels and 1/16-in. washout in the tips; this reduces drag. Because of the reduced drag and the lighter weight of the model, the altitude gained on power has been improved. There is 0° of downthrust and 1° left thrust. The model is neutral and easy to trim. All of this is designed to increase the acceleration and altitude obtainable from the four-second engine run, and to better the chances of making the 2½-minute max.

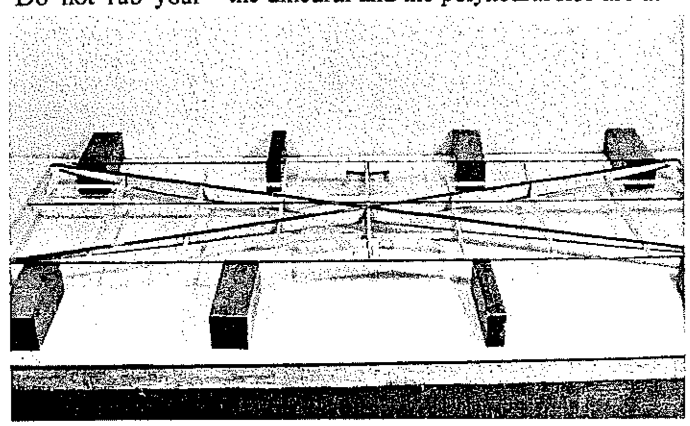
Construction. To say the least, construction is very unusual. The X-frame adds tremendous rigidity while the judicious use of carbon fiber materials provides lightness. The carbon fiber rod is easy to cut and handle and has no slivers. I use an electrician's combination stripper/cutter tool—just put it in the 4-40 bolt cutter hole and it shears the carbon fiber off cleanly. Carbon fiber sands or files readily.

The .007-in. laminate is unidirectional. While very strong and dimensionally stable lengthwise, it is very easily split across the grain as well. The easiest way to cut it is to snip it to the desired width and then strip it to the length needed. Do not rub your fingers along the edges, because (as with plywood) you can pick up slivers.

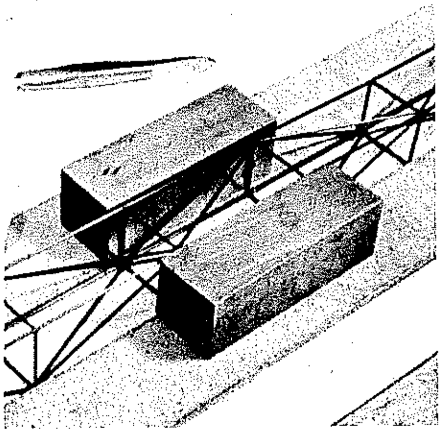
Cyanoacrylate (CyA) glues work fine, but epoxy, which is heavier, is also good. Since CyA attracts and absorbs the fuel-oil mix that we use, make sure you don't use it around the firewall or the fuel tank. Use epoxy there and wherever the glue joint could be exposed to fuel.

Wing. Use two straightedges (over the plans) as guides for the leading edge (LE) and the trailing edge (TE), and make sure they are straight. (I use ⅛ x 1½-in. aluminum strips from a builder supply.) Drill small holes in these strips and, with small brads, nail to the building board. Using pins on an angle, pin the LE and the TE against the straightedges. Position the bottom spar and hold it in place with crossed pins or weights. Glue the ribs in place, making sure the dihedral and the polyhedral ribs are at

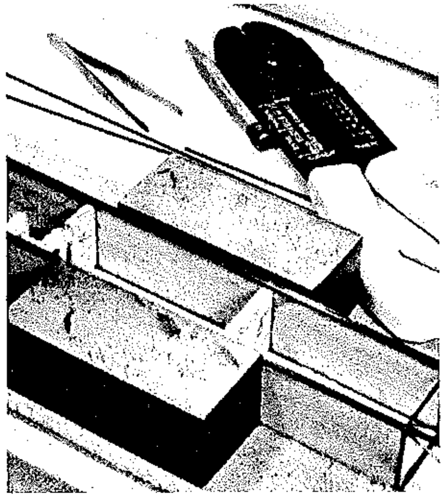




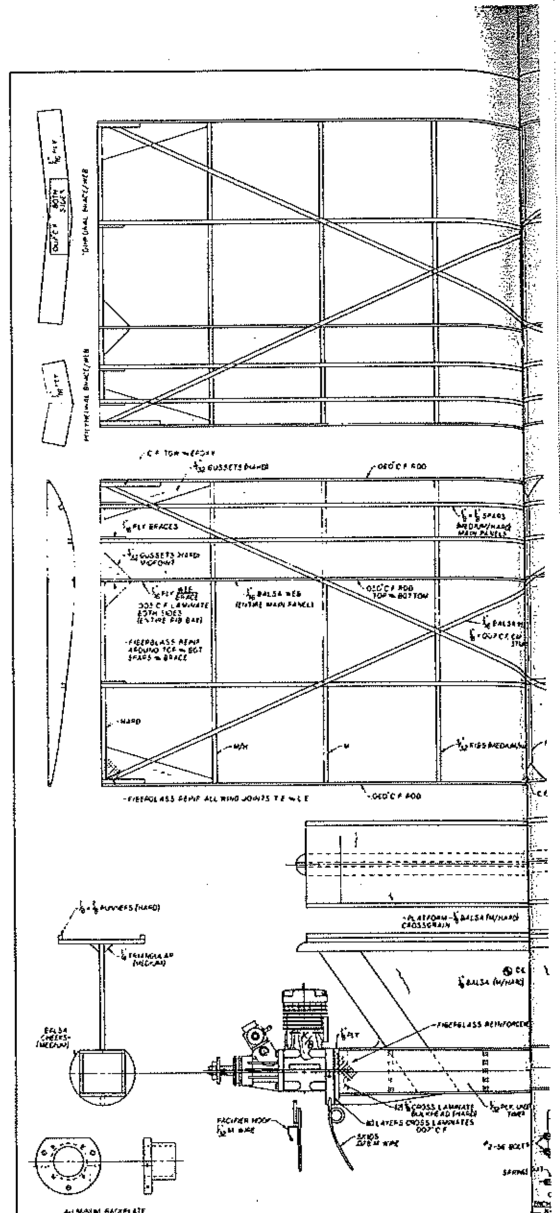
Left: As was done with the wing center section, the stab is pinned into position for installation of the C.F. cap strips. Right: Once the glue cures on the C.F. strips on the top of the stabilizer, it is flipped over, squared up on support blocks, and then the C.F. cap strips are added to the bottom.



The fuselage is assembled from carbon fiber rod. The is a Warren-truss type construction which is not only lightweight but strong and super rigid.



The front end of the fuselage with the bulkheads in place. The tie in the bulkheads will be removed after the slot is cut into the top deck. The C.F. rod is best cut with wire strippers as shown here.



the correct respective angles.

Fit and glue the webbing (for the carbon fiber cap strips) in place; the grain of the webbing is parallel to the bottom. Leave the top of the webbing a little heavy, to be sanded flush with the ribs. (Note: With this method, the carbon fiber cap strips will be slightly above the surface of the ribs. They can be inset flush if you wish. I have done it both ways, and have found insetting to be a lot of work with little compensating advantage other than neatness.)

Carefully sand the tops of the webbing flush with the ribs. (I mark the tops of the ribs with a very soft charcoal pencil to be able to tell when the sandpaper has cut down to the ribs.) Cut the slots for the spar and the turbulator spars in the webbing and glue them in place. Keeping the carbon fiber cap strips centered (approximately), glue them in place on top of the webbing. Note: Make sure the panel is perfectly flat or is blocked up to the warp that you want. Once the cap strips are glued to the webbing, it is impossible to change the panel structure.

Turn the panel over and block up the LE and the TE so that the panel is either flat or to the warp that you want. Glue the bottom carbon fiber cap strips in place. Now run a bead (fillet) of slow-set CyA along the webbing and cap strips and hit it with accelerator. This is a very important step—don't eliminate it. I use the fillet on both sides of the webbing, top and bottom, for the wing, but on only one side for the stab. Fit and glue the main spar webbing. Vertical grain is OK here, but not necessary.

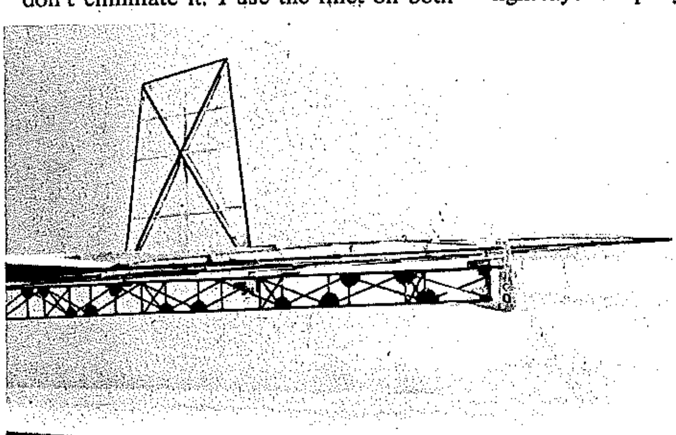
Complete all wing panels in this fashion. Before joining the panels, carefully cut a slot in the dihedral and polyhedral ribs between the main spars for the plywood brace/webbing. Line up and block up a main wing panel and its matching tip panel. Carefully fit the plywood brace/webbing between the main spars until it is a nice, easy fit—no binding anywhere. You will have to remove and replace one panel as you do this.

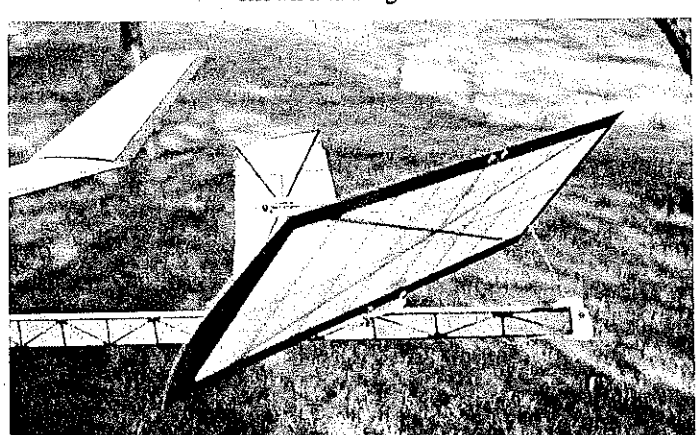
With the panels lined up and blocked up, spot-glue the brace/webbing to the main panel. Now you can slide the panels apart, apply glue (very slow-set CyA works here), slide them back together, and allow to set in the lined-up, blocked-up position. Assemble the entire wing in this fashion.

Add the LE and TE dihedral and polyhedral braces as shown. These are built up from carbon fiber tow or carbon fiber rope and epoxy. I find that Hobby Poxy #2 works very well here. It wets the tow better and has a longer working life (also a longer curing time).

Cut the slots for the braces (nothing fussy here) and cover the slots at the bottom of the wing with a heavy masking tape. Put a light layer of epoxy in the bottom of the slot right on the tape. Now take a small bundle of carbon fiber tow (approximately 1/16-in. diameter) and spread it evenly in the bottom of the slot. Add another layer of epoxy and then a layer of tow until the slot is filled. Build the top up a little for sanding after it is cured. These braces are much stronger than plywood.

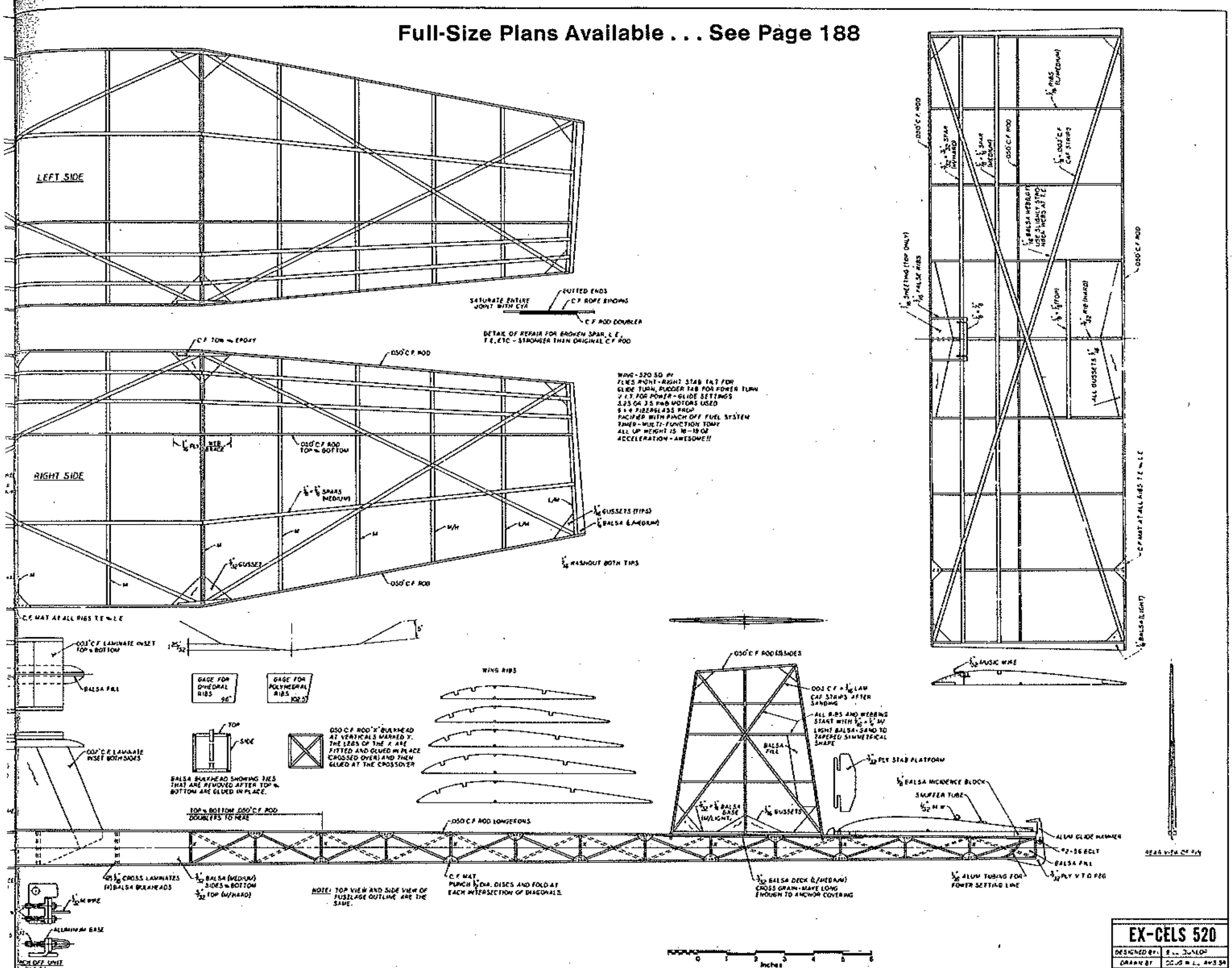
Glue the fiberglass reinforcements where shown and the gussets at the centerline. Cut





Above: The DT and V.I.T. setup. Note the gussets and construction particulars. This arrangement is ultra-light and well suited for this model's short nose moment. Left: The retaining cable on the stab prevents it from DTing up past approximately 45°. Set the DT fuse for short flights when trimming.

Full-Size Plans Available . . . See Page 188



¾-in. squares of carbon fiber mat and spray one side lightly with 3M 77 contact glue. Before the glue is dry, wrap these squares around the LE and the TE at the ribs. Squeeze together gently (do not tear apart) and hit with penetrating CyA. This method makes a very strong joint despite the minimal glue and wood area. You now have a wing that is very light, very strong, and rigid enough for the lightest, most flexible of the iron-on plastics.

Stab and Fin. The stab construction is the same as the wing—just keep it light.

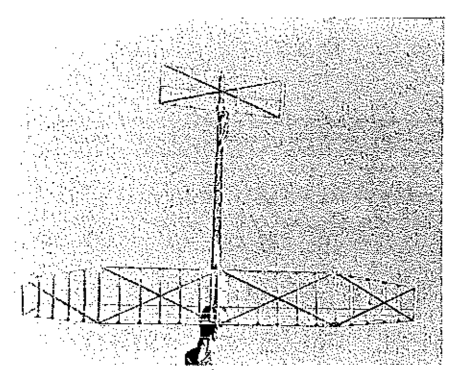
As with wing and stab construction, making the fins also involves unconventional methods. Glue the carbon fiber rods and the gussets together for the outline (three sides, no base). Block up the outline to the correct height and glue the base, ribs, and webbing in place. Sand to a tapered, symmetrical shape. Add the carbon fiber cap strips (both sides) to the webbing while the outline is on the same blocks.

Fuselage. Make the sides first. Set up the straightedges using the same method as for the wing, and pin down the longerons. Fit and glue the verticals and the diagonals. Add the front side balsa panels. Be sure to make a right and a left side (the right side and left side diagonals are also different). Fit and glue the front carbon fiber longeron doublers.

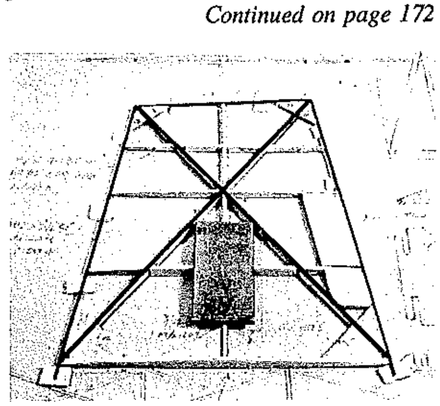
Without changing the straightedges, stand the sides up with the top edges down. Fit the crosspieces. (I make the top and bottom pieces exactly the same length and glue both in as I go along. An alternative method is to finish the top first and then turn it over to finish the bottom.) I use blocks of cold rolled steel 1¼ x ¼ x 3 in. to help keep everything square.

Add the deck for the fin. Fit and glue the diagonals as you go. Fit and glue the top front deck (without the pylon slot in it). Laminate and fit the front bulkheads. Make sure they will be the right height for the bottom deck before gluing in place. Partially cut the pylon slot in the center (each bulkhead is different!). Leave small ties near the top and bottom to be removed later. Do this before gluing in place. Fit and glue the bottom deck.

Continued on page 172



The bare-bones structure shows off the ultra-light construction. X-cell structure provides rigidity.



Block up the perimeter of the fin to install the cap strips. When in place, secure with a small weight.

The Whitehead pre-Wright flight controversy is heating up, abetted by the continuing efforts of a dedicated group of aero-historians and craftsmen up in Fairfield, CT, where Gustave Whitehead may have beaten Wil and Orv into the air by a couple of years.

These folks have built a replica of the No. 21 Whitehead machine which first flew in the summer of last year and will probably have been further test flown by the time you are reading this. Flights of up to 330 ft. in length at altitudes of up to five feet have so far proven that the craft is not only airworthy, but that it is controllable using the throttles. (The No. 21 had two props, remember?)

Testing will enter a new phase when the Whitehead engines can be replicated and installed to replace the present ultralight-type engines. One interesting sidelight of the replica's flights has to do with the still-air takeoff capabilities of the ship. It *did* take off and fly in still air.

If you will recall, the original Wright flier was *not* capable of taking off in still air under its own power and required a 27-mph head wind at Kittyhawk and a catapult in Dayton.

Whitehead had two 10-horsepower engines as opposed to the Wright's single 12-horsepower one. (He also had another engine connected to the front wheels to get up to takeoff speed!) Remember that horsepower ratings back in those days gave more low-rpm torque—a fact discovered when the replica builders for the film, *Those Magnificent Men and Their Flying Machines* had problems getting into the air with modern, high-revving engines with *double the horsepower* of the originals.

Bill O'Dwyer, who almost single-handedly kept the Whitehead inquiry going over the past 25 years, says that we should watch "60 Minutes" in October, when many Americans will get their exposure to the Whitehead flights for the first time.

Continuing with the subject of dummy engines, an interesting approach to the subject is suggested by Gene Pierre (Princeton, NJ). He manufactures nifty fake fins to wrap around partial cylinders by smoothing a piece of aluminum foil on a flat, clean surface using the edge of a flat rubber eraser. He next places the foil, dull-side-up, over a file which has clean, undamaged, parallel teeth. (He uses a flat, single-cut file about one inch wide which has about nine inches of toothed area.) He then rubs the foil with the *end* of the eraser in the direction of the file's tooth ridges.

After removing the foil from the file, Gene paints the foil a dull black (with Floquil model railroad paint), allows it to dry, and lightly sands in the direction of the ridges. This may require two coats. The idea is to clean off just the high parts and leave the black paint in the grooves.

He then cuts strips of the finished product 90° to the lines and about ½-in. wide and glues them to balsa dummy "cylinders" using medium CyA glue. The sample he sent is quite striking. It may be just right for your next Peanut project.

Applications for planes larger than Peanuts can be done by the simple expedient of cutting some strips of thin plastic (credit cards are about right) the width of the fins desired. Strips about one inch long and ⅜-in. wide are good. Then, glue them into a stack, with alternating edges about 1/16 in. lower. Thicker strips or doubled strips can be used in between "fin" pieces. Then, level one side so that all the strips are even.

In effect, you have made your own "file" such as Gene uses, but with different spacings between fins and different fin widths. Some practice in getting just the right depth of impression on the foil using the bigger sizes is necessary. But then, foil is cheap. If you get the grooves a little too deep, you can pull them a little flatter after painting and sanding so they'll wrap around your dummy cylinder more easily.

Finally, any of you who had planned the pilgrimage to Southern California for the Flightmasters Annual in September should be advised that this event has been put off until December 5-6, 1987. Events will include Rubber AMA Scale, Gas AMA Scale, Peanut Scale, Jumbo Scale, Multi-Engine Scale, and FF Jet Scale. There will be a banquet Saturday night following Scale judging, and flying is set for a new field near March AFB on Sunday. Drop me a SASE for more details.

Until next time, keep using wooden props so as not to bend yer crankshaft in a crash!

Bill Warner, 423-C San Vicente Blvd., Santa Monica, CA 90402.

Ex-Cels/Dunlop

Continued from page 79

Remove the fuselage from the board and fit and glue the carbon fiber X bulkheads. This part is guaranteed to try your patience, but hang in there. Now punch out ½-in.-dia. discs of carbon fiber mat. Lightly spray one side with 3M 77 contact glue and, before the glue is dry, fold around the joints where

Continued on page 174

the diagonals come together. Hit with penetrating CyA.

Install the 1/32 ply timer plate, blind nuts, and timer. Don't forget to install whatever dethermalizer (DT) hardware or auto control setups you are going to use at the proper phase of construction.

Accurately cut the pylon slot in the top deck and remove the ties from the bulkheads. Note: The slot is made long, or can be made longer, to adjust for center-of-gravity positioning. Install the cheeks and carve to shape. Laminate, add blind nuts, and install the firewall.

Install the stab platform, incidence block, and VTO (vertical takeoff) peg. Laminate and build the pylon and the wing platform. (I inset the carbon fiber strips in both the pylon and the platform so they are flush—makes for a neater job.) Fit the pylon to the fuselage, making sure that the angle of attack is correct.

Covering. You can use any covering material you desire without worries about structural rigidity. This is the lightest, strongest, most rigid construction ever, and even the lightest, most flexible of the iron-on plastics is acceptable.

I use Micafilm, which is light and strong but difficult to handle. Here's my method: On the rear of the fuselage, the stab, the fin, and the wing tips I use the clear, lightest-weight Micafilm, while the main wing panels are covered with the stronger, heavier white film. Use 3M 77 contact spray or Balsarite (thinned to 60% glue, 40% thinner). Put two coats of the thinned Balsarite (or one coat of 3M 77 spray) on all surfaces that will contact the covering (except the carbon fiber cap strips).

Cover the bottom first. Securely adhere the cover to the wing outline. Shrink the cover gently on low heat. Trim the outline and go over the glue contact line (inside the carbon fiber rods) with penetrating CyA—not too much, and no accelerator!

Cover the top using ¼-in.-minimum overlaps. Use 3M 77 spray or two coats of thinned Balsarite on the overlaps. Shrink the top gently on low heat. Now hit all the edges of the overlaps with penetrating CyA—and, again, no accelerator. Shrink it completely on high heat, top and bottom.

Check for and remove any undesired warps. Now run the iron (on low heat) over every surface that contacts the covering (ribs, spars—but not the carbon fiber cap strips). The way to do this is to slowly run the iron over a small contact area, then rub it firmly with your finger until it cools and is set. (Don't burn your fingers!)

After completing this step, go over the entire surface on high heat and check for warps. This locks the covering up tight everywhere and is easier to patch. I outline the wing and stab with fluorescent orange paint for its exceptional visibility. Clean the area to be painted with dope thinner for better adhesion. After the orange paint is sprayed on, apply a coat of Super Poxy over it.

Center-of-gravity (CG). Before finishing the front end, assemble all parts and hardware on the model—and that means everything! To be on the safe side, add about two grams of weight on the rear. Now shift the pylon forward (or backward, as the case may be) to the indicated CG—about 66%. At 69% the model becomes unstable. After disassembly, glue the pylon in this position.

Follow your own favorite, time-proven method to finish the front end. I use lightweight fiberglass (or tissue), nitrate dope, and Super Poxy. Add your decals, AMA number, nameplate, etc., and assemble. Make sure the wing is on at exactly 90° and key it on. Note: Many puzzling power patterns on high-speed models can be attributed to a wing that is not perfectly lined up, and this is especially true on a very hot model. Recheck the CG.

Flying. Check out all systems on the ground while the engine is running. I use a pacifier fuel system (for pressure) with a pinch-off fuel cutoff. The very close proximity of the pinch-off to the venturi provides a very quick, positive shutoff with no danger of leaning out and blowing a plug. As a result, plugs last longer and I can consistently run on higher nitro than I could on the old flood-off system. My first flights are on 40% nitro, with a 3- to 3½-second run and quick DT (four to five seconds).

I use rudder tab and adjust the incidence block to control the power pattern. The ideal pattern is just about vertical with a slight twist to the right. When it looks good, gradually increase the engine run by about one second each time, and adjust. When the model can hold the power pattern for seven seconds (or longer), test and adjust the variable incidence tail (VIT) for glide. I use stab tilt for the glide circle. A seven-second engine run and 15-to 20-second glide to DT should keep the model out of trouble.

Once the glide has been adjusted, increase fuel to 50% nitro and start over on the pattern: 3- to 3½-second engine run and adjust, etc. Do this each time the nitro percent of the fuel is increased. You now have a model that is super-light, super-strong, and very competitive. Handle it with TLC, and see you at the flyoffs!

Sources for carbon fiber material: (1) Bob Violett, 1373 Citrus Rd., Winter Springs, FL 32708 (.050-dia. rod, mat, rope, and laminates); (2) Twinn-K, Inc., P.O. Box 31228, Indianapolis, IN 46231 (.070-dia. rod and laminates); (3) Jim Bradley, 1337 Pine Sap Ct., Orlando, FL 32817 (.060-dia. rod, mat, and laminates); (4) Aerospace Composite Products, P.O. Box 16621, Irvine, CA 92714 (.050-, .060-, .070-dia. rods, mat, rope, and laminates).

Indoor Champs/Linstrum

Continued from page 82

and built the magnificent 1909 Aerodrome Silver Dart mentioned earlier. This was the first Canadian-designed aircraft to fly. With a canard pusher configuration, the model is reminiscent of the Wright flyer. Jeurgen, an MAAC member and protege of Scale expert Ken Groves, is a mechanical engineering student at the University of Waterloo, Toronto. Jack Humphries suggested he build it, so he researched the model, finding most of his information in the *Hammond's Sport Era*, which covers many pioneering types. A modeler since 1980, Jeurgen devoted over a month of building-time to this gem. Complete with wire bracing and controls, it is of museum quality—yet has had flight times over 30 sec.

Another up-and-coming Scale flier is 24-year-old Kevin Smith of Ft. Lauderdale, FL, who labored long into the night and on

Continued on page 176