Building From

WE ARE GETTING close to a wrap for my portion of the "From the Ground Up" series. In the past eight months you have learned about Radio Control (RC) systems, electric-power systems, assembling an Almost Ready-to-Fly (ARF) model, flying that model, and last month you learned the A to Z of batteries.

The next step could have gone in either of two directions: building a model from a kit or building a model from raw materials—from scratch! I chose the latter and came up with a new RC trainer design that I call the "Scratch-One."

The idea was to utilize the RC system and the electric power system from the Aero Craft Pogo ARF. The Scratch-One RC trainer design is slightly larger and slightly heavier than the Pogo. Specifically, the wing area is 247 square inches, the wingspan is 45 inches, and the all-up weight is 16.9 ounces (approximately an ounce heavier than the Pogo).

The Scratch-One design can be classified as an RC electric-powered trainer sailplane. It has proven to be one of the most forgiving designs to fly and perfect for the RC beginner, but keep in mind that the thrust of this article is to get you to build your first model from scratch. The pieces won't be fabricated or preassembled; it is all going to be strictly up to you. As part of the process you will also cover all or part of your model.

Obtaining the necessary balsa, plywood, and spruce pieces to construct this model took at least three visits to local hobby shops; not every hobby dealer will have every stick you need. I thought this might be an initial point of frustration, so I came up with an idea.

Craig Wagner, who owns Aero Craft, agreed to make a box of wood for the Scratch-One. It will have all of the wood material you need, and in the correct sizes. The only things you will have to purchase on your own are the cements, covering material, and hardware such as control rods, control horns, and control-surface hinges. You can reach Craig at Aero Craft Ltd., 432 Hallett Ave., Riverhead NY 11901; Tel.: (631) 369-9319; Web site: www.aerocraft rc.com.

(Editor's note: Since this article was written, we have received pricing and shipping information from Aero Craft Ltd. for the materials to build the Scratch-One. The "kit" of materials is $19.95 plus $6 shipping and handling. This kit will come packed in a 4 x 4 x 36-inch mailer box.)

About the Design: Before I get into the construction, I want to point out some of the Scratch-One's design features. Cutting out wing ribs can be a tedious job, especially for a beginner. So in this design I eliminated all wing ribs and substituted balsa sticks.

The bottom stick is ⅛ x ¼ balsa. Next come three different-size wing spars, then 1/16 x ¼ balsa sticks are bent over the spars to provide the necessary airfoil shape. The leading edge is common 3/16-inch-diameter hardwood dowel. You won't likely experience much damage on rough landings with this kind of construction.

I also made the wing's center-section flat so that no center joiner or brace is necessary. Both tips are raised 4½ inches for what we call "polyhedral." These raised tips provide overall stability in flight.

Many models have what I call "internal" battery compartments; to access the battery pack for charging purposes, you must remove the wing. I find that annoying and time-consuming, so in this design the battery compartment is on the bottom of the fuselage where it can be accessed directly without touching the wing.

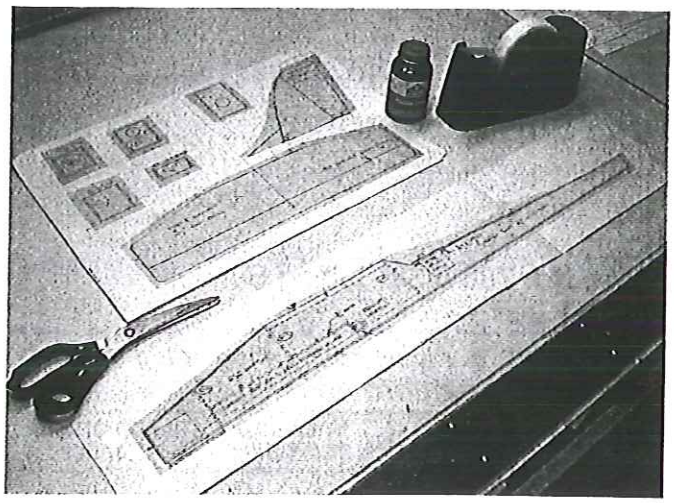
Probably the most difficult task for the beginner is to mount the servos and hook up the control rods that operate the rudder and elevator. To keep it simple I placed the two servos on top of the fuselage, just aft of the wing trailing edge. It's kind of like "letting it all hang out"!

The control rods are run externally from the servo output arms back to the control horns on the rudder and elevator. This makes for easy control throw adjustments and easy centering of the controls. These few ideas made the Scratch-One extremely simple to build and fly!

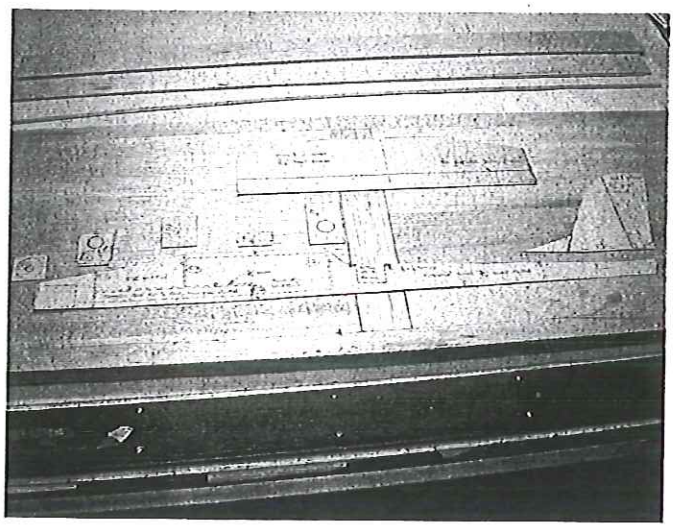
CONSTRUCTION

I like to make my own "kit" of parts before starting the assembly. On this model you must make two fuselage sides and all of the tail pieces from 3/32 balsa. You also have to cut out four fuselage formers from 1/16 plywood and a fifth former from 3/32 balsa. The last items are two 1/16 plywood wing-panel joiners—one for each tip panel.

To cut out these parts I take the plans to a copying store, such as Kinko's, and have photocopies made of the parts to be cut out. I paste these copies to manila-folder stock



To prepare templates, make copies from plans and cement them to manila-folder stock. Use rubber cement and 3M Magic Tape.

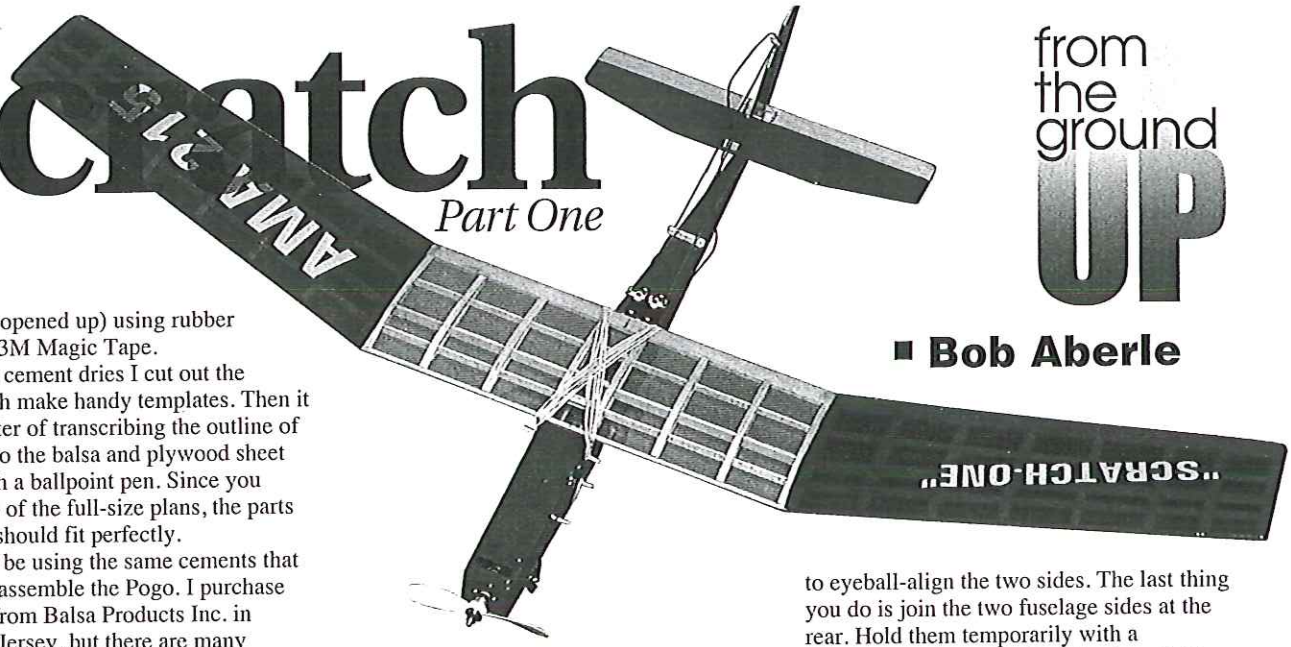


Templates after having been cut from manila-folder stock.

Scratch *Part One*

from the ground UP

■ **Bob Aberle**



(file folders opened up) using rubber cement and 3M Magic Tape.

After the cement dries I cut out the pieces, which make handy templates. Then it is just a matter of transcribing the outline of the parts onto the balsa and plywood sheet material with a ballpoint pen. Since you made copies of the full-size plans, the parts you cut out should fit perfectly.

You will be using the same cements that you used to assemble the Pogo. I purchase all of mine from Balsa Products Inc. in Iselin, New Jersey, but there are many supply sources. You will need thin and thick cyanoacrylate glue (CyA) with an accelerator (in a spray bottle) and five-minute epoxy cement for the high-stress areas such as the firewall, wing-panel joints, and stabilizer/vertical fin attachment to the fuselage.

Because the wing requires no ribs, all you need is a bunch of balsa sticks. The bottom of the airfoil is made from ⅛ balsa sticks. Add the three spars, and the last step is to bend 1/16-inch-thick strips over the spars, forming the airfoil shape of the wing. You may find that briefly soaking these strips in water will make them bend easier.

When assembling the wing, take note that the middle spar in the center panel is ⅛ x ⅜ spruce (a hardwood); that is for extra strength. On the tip panels, to maintain a gradually thinning airfoil shape it is necessary to taper the spars from the panel joint out to the tip. For that reason all of the tip-panel spars are made from balsa so that they can be easily tapered (cut). Each wingtip is simply capped off with 3/32 balsa and sanded to blend in.

Fuselage: Trial-mount your Speed 400 motor to the plywood firewall F1. You will need to drill a clearance hole in the center along with two screw holes. The screws are 2.6 millimeter, which you can obtain from Kirk Massey at New Creations R/C. Leave the motor off until after F1 is cemented to the fuselage sides.

Add 1/16 x ¼ spruce stiffeners to the wing-mount and battery-compartment areas. This provides extra strength and should not be omitted. When you cement the stiffeners in place, remember that you are making one left fuselage side and one right side.

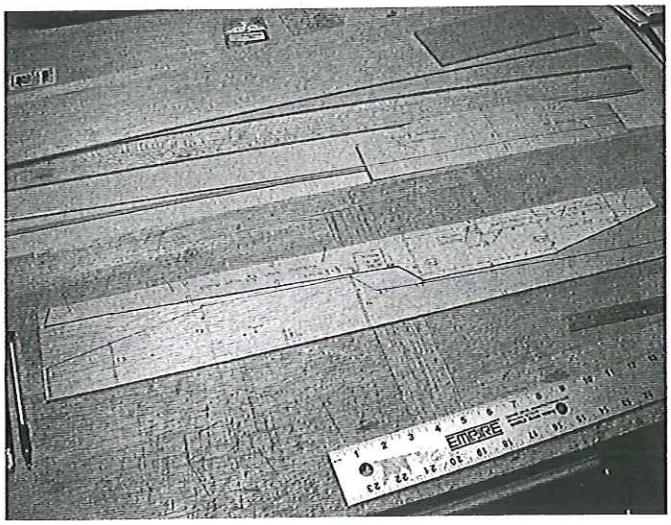
Now you can cement the formers in place, first to one side using a square or triangle to make sure that they are aligned properly. You can use thin CyA to spot the formers in place, then follow up with thick CyA, which adds more strength.

Attach the firewall (F1) with five-minute epoxy cement. Once formers F1 through F4 are in place, add the other fuselage side. Try to eyeball-align the two sides. The last thing you do is join the two fuselage sides at the rear. Hold them temporarily with a clothespin and cement them in place (with thick CyA).

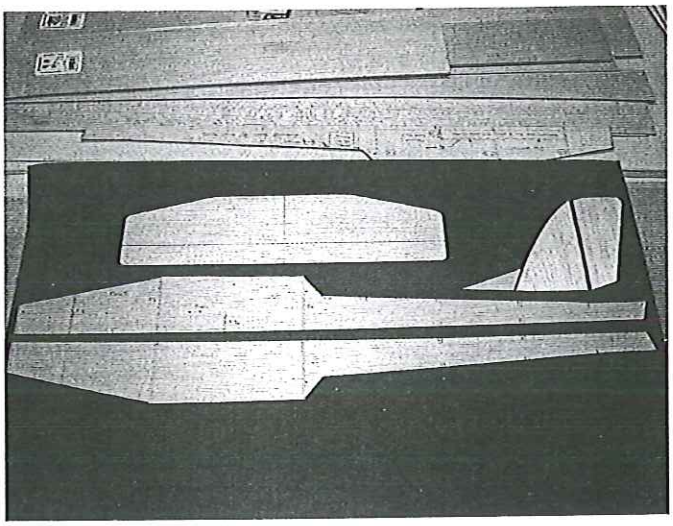
Add the two ⅛ x ¼ spruce servo-mounting rails which are located on top of the fuselage, just aft of the wing trailing edge. The Hitec HS-81 servos are mounted to these rails using the supplied wood screws (two for each servo). Run the cables coming from these servos through the hole in former F4 and into the receiver compartment, just below the wing.

Mount the Speed 400 motor in place with the two screws, and install the Jeti JES 110 Electronic Speed Control (ESC). The motor cables run through the hole in former F2. Then the ESC servo cable passes through the hole in former F3. I used double-stick tape to hold the ESC to the fuselage side. Install the ESC switch on the left side of the fuselage. Before adding the sheeting, install the battery-compartment floor, which is made from 3/32 balsa.

With this done, you can apply the 1/16 sheet top and bottom to most of the model. For example, do the fuselage top from the servos to the leading edge of the stabilizer,

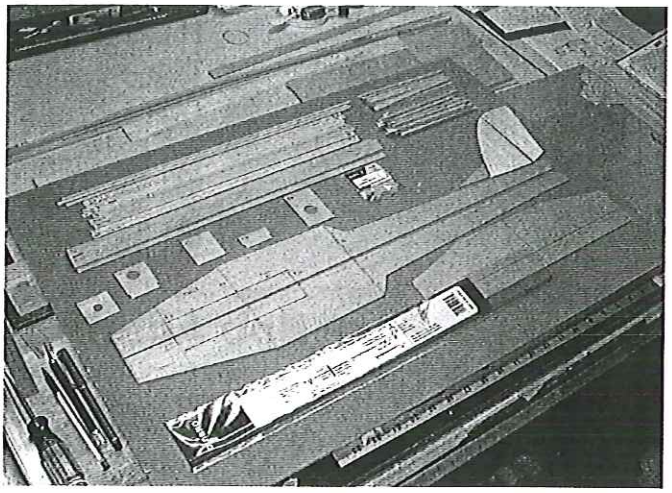


Use cut-out templates to trace patterns onto raw balsa sheeting.

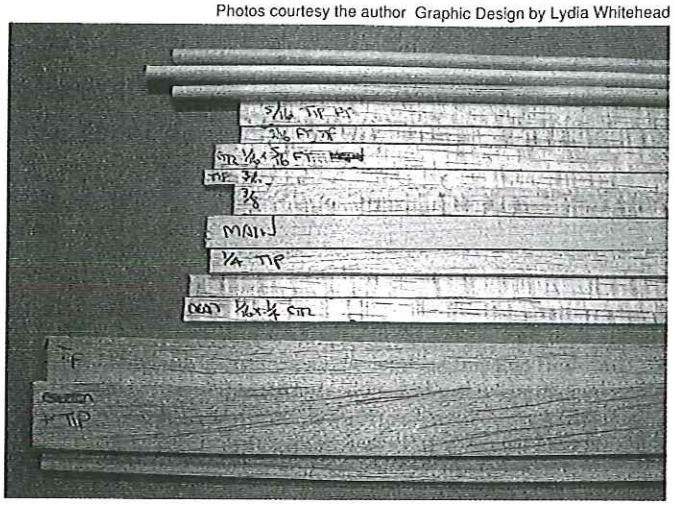


Cut parts from sheeting using sharp X-Acto #11 knife blade.

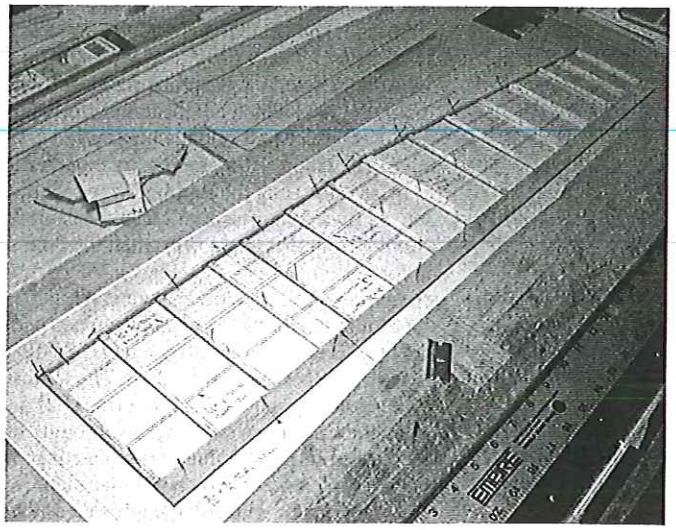
Photos courtesy the author Graphic Design by Lydia Whitehead



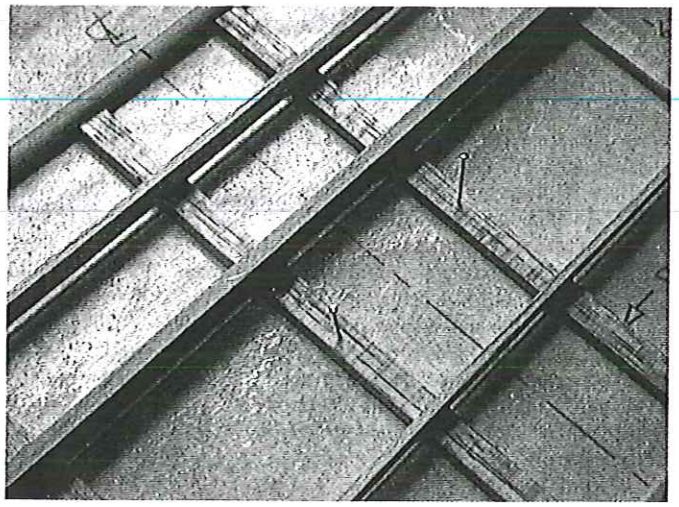
All of the balsa-sheet pieces are ready for assembly. The wing parts are literally a bunch of balsa sticks.



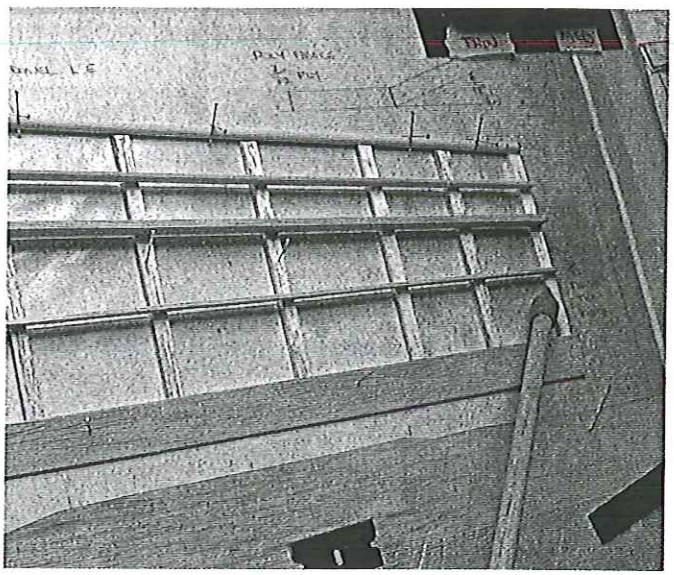
Leading-edge material, at top, is common 3/16-inch-diameter hardwood dowel. Spar material is in center. The main, center spar is made from spruce—a hardwood—for extra strength.



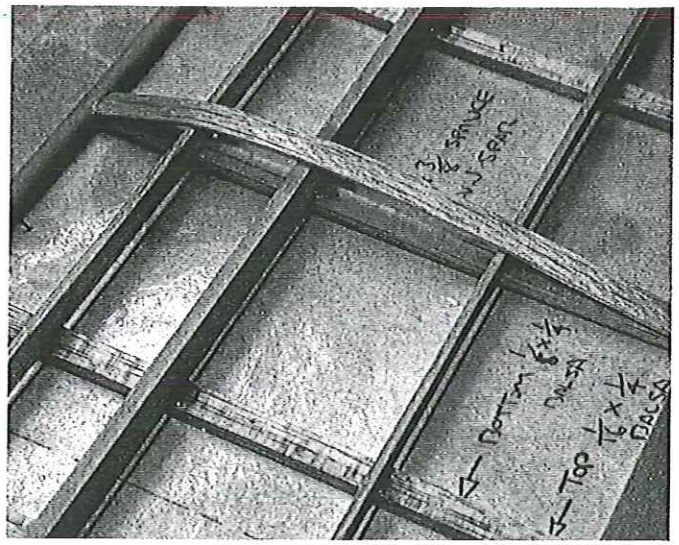
Starting wing construction. Leading edge is pinned in place, then bottom 1/8 x 1/4 balsa sticks are set in place. Triangular-shaped trailing-edge stock is at other end.



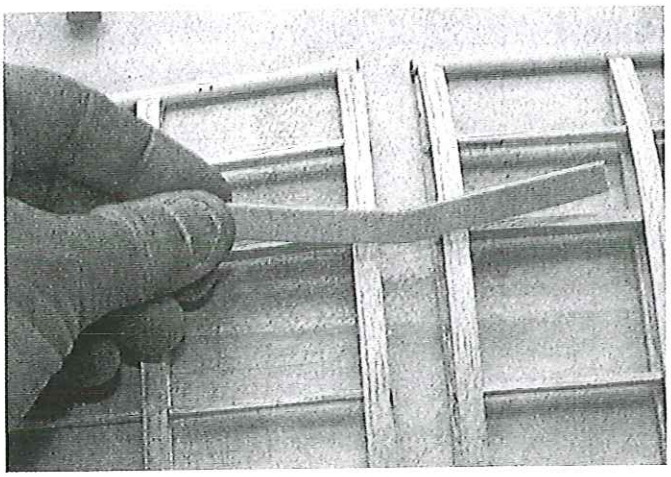
The three wing spars are added on top of 1/8-inch-thick balsa strips. Remember that these spars on both tip panels taper as they go out to the tips.



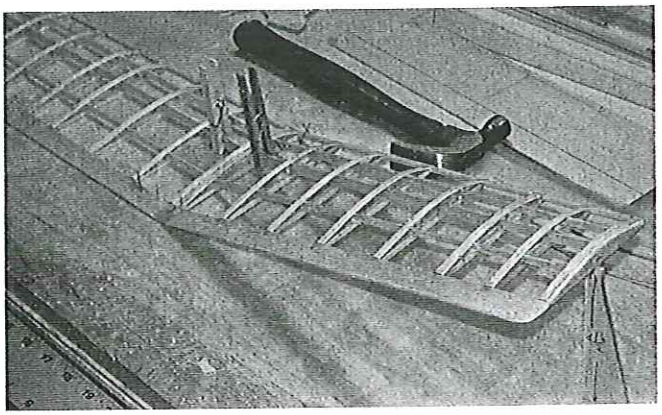
Notice how the spars taper going out to the tip. You cut this taper with the help of a long, steel straightedge.



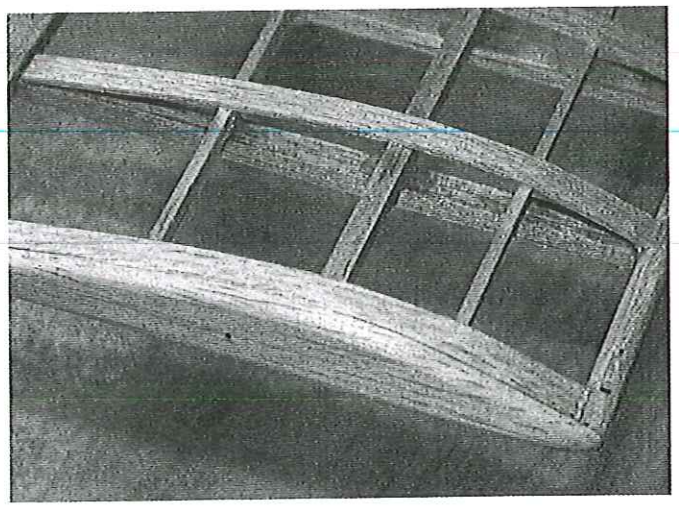
Complete airfoil by placing 1/16-inch-thick balsa strips on top of spars. Soak strips in water so they will bend easier.



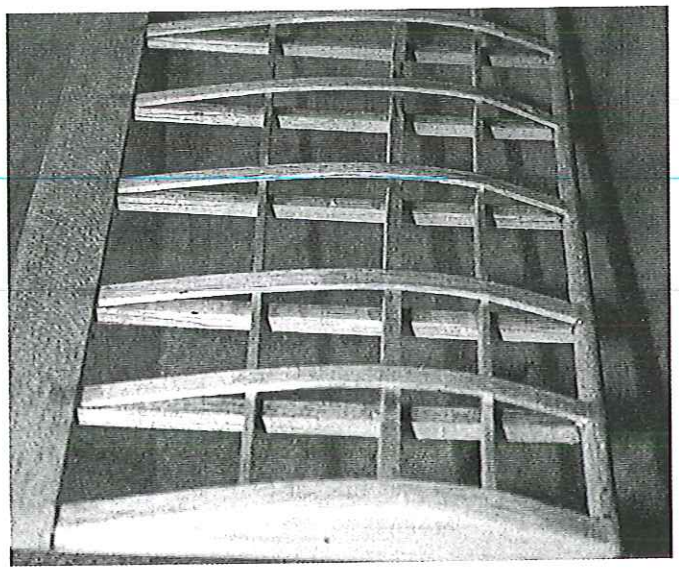
Shown are the plywood wing-panel joiners or braces. You will need two: one for each wingtip panel.



Make wingtip-panel joints at proper polyhedral angle of 4½ inches off of building board. Clothespin holds plywood wing brace in position until five-minute epoxy sets.



You can see the wingtip detail. Fashion each tip from scrap pieces of 3/32 balsa, sanded to a smooth contour.



Looking from wingtip toward center of wing. Neat construction!

then sheet the entire bottom of the fuselage. With all of this sheeting, the grain runs across or at right angles to the fuselage sides. The only sheeting you leave open at this point is the top from the firewall to the wing leading edge.

At this point I am going to break for this month. Since this is a beginner's first-time scratch-built model, the final tally came to more than 50 photographs to support the article. Not wanting to cut anything out, the editors decided to divide the Scratch-One construction article into two parts. I chose the start of covering as the logical point to make the break.

Next month is the Nationals-coverage issue, but in the January issue I will start with control-surface hinging and proceed all the way through the Scratch-One's first flights. For your convenience, the plans and specifications are included with Part One. With this information you can purchase the balsa, cut out the parts, and do the assembly work. Thank you for your patience. *MA*

Manufacturers:

Du-Bro Products (control rods, control horns, keepers)
Box 815
Wauconda IL 60084
(800) 848-9411
www.dubro.com

Hitec RCD (Neon RC system)
12115 Paine St.
Poway CA 92064
(858) 748-6948
www.hitecrcd.com

Hobby Lobby International (propellers)
5614 Franklin Pike Cir.
Brentwood TN 37027
(615) 373-1444
E-mail sales: sales@hobby-lobby.com
www.hobby-lobby.com

New Creations R/C (electric power system)
Box 497
Willis TX 77378
(936) 856-4630 (telephone calls are preferred)

SR Batteries Inc. (Gapless Hinge Tape, *R/C Techniques* on covering application)
Box 287
Bellport NY 11713
(631) 286-0079
Fax: (631) 286-0901
support@srbatteries.com
www.srbatteries.com

Balsa and plywood raw-material suppliers (in addition to Aero Craft Inc.):

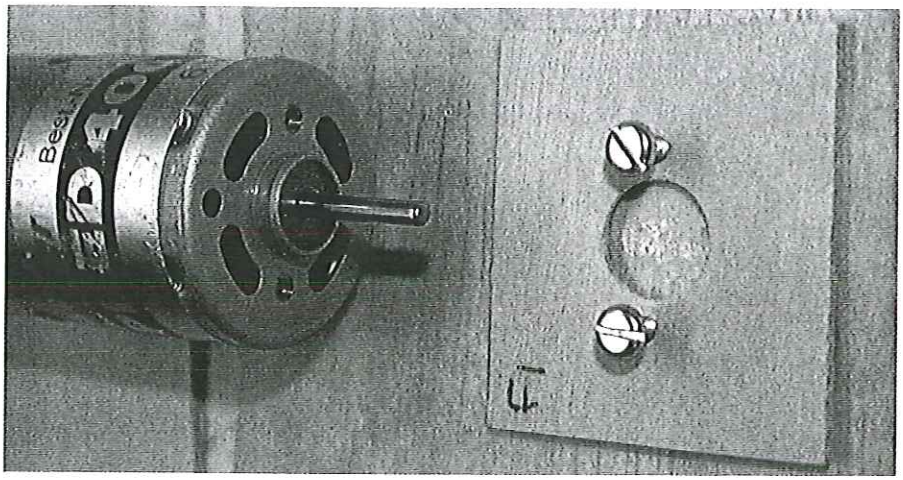
Lone Star Models
115 Industrial St.
Lancaster TX 75134
(800) 687-5555
www.lonestar-models.com

National Balsa Co.
97 Cherokee Dr.
Springfield MA 01109
(413) 796-1925
www.nationalbalsa.com

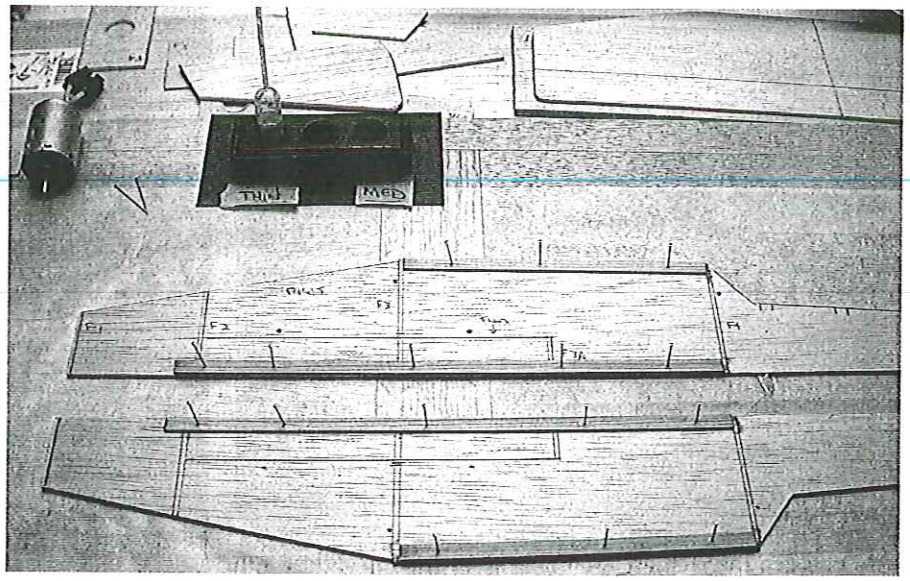
Superior Balsa & Hobby Supplies
12020-G Centralia
Hawaiian Gardens CA 90716
(800) 488-9525
www.superiorbalsa.com

Scratch-One Specifications

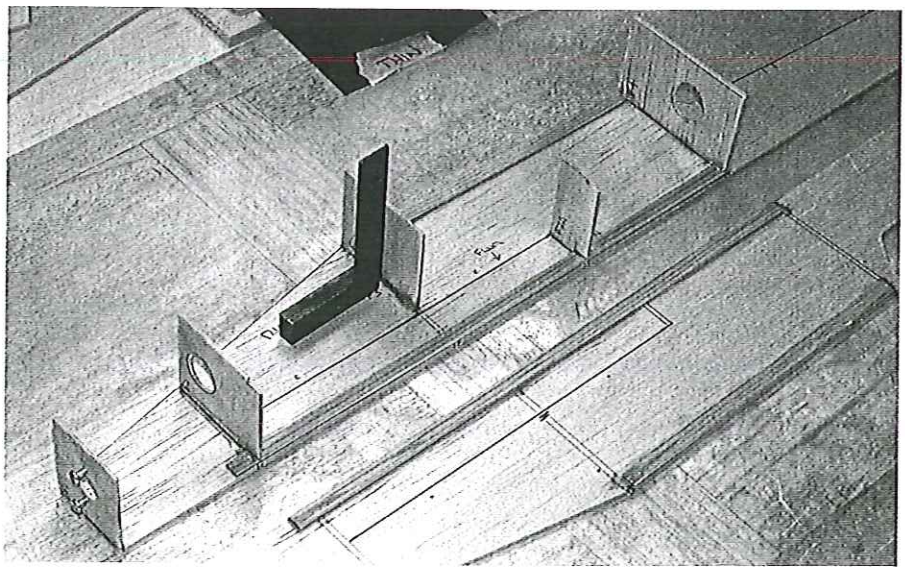
Type: Electric-powered RC sailplane/basic three-channel trainer
Wingspan: 45 inches
Wing area: 247 square inches
Weight: 16.9 ounces (with a 78-cell 1100 mAh NiMH battery)
Wing loading: 9.8 ounces per square foot
Length: 29 inches
Motor: Speed 400 direct drive
Propeller: Gunther 5 x 4
Motor current: 12 amps (at start of run on full charge)
Motor power: 90 watts
rpm: 13,900
Watts per ounce: 5.32
Battery: Eight-cell 1100 mAh NiMH
Radio used: Hitec RCD Neon three-channel transmitter (with control options installed), Hitec Electron 6 micro dual-conversion receiver, two Hitec HS-81 servos, Jeti JES 110 ESC
Flight duration: Almost six minutes at full throttle. Close to 10-minute motor-run time at half throttle.



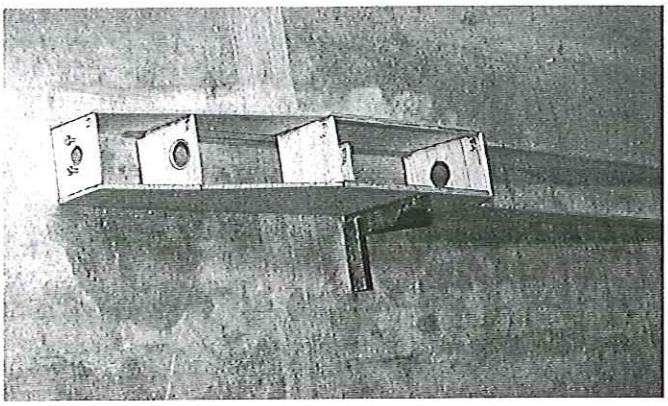
This photo shows the mounting of the Speed 400 electric motor to the plywood former F1 using two 2.6-millimeter machine screws.



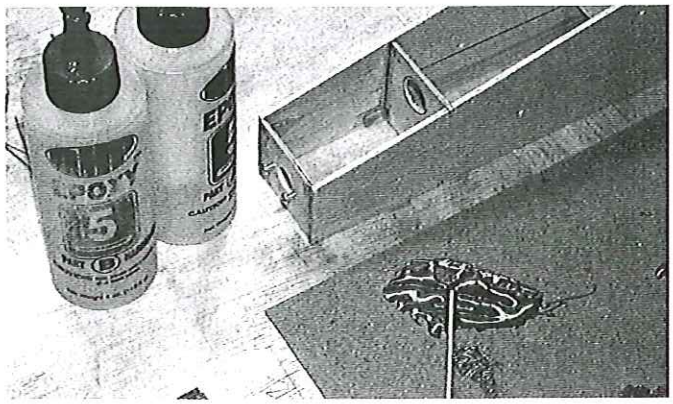
Add 1/16 x 1/4 spruce stiffeners as shown to wing-mounting area (top) and edges of battery compartment. *Be sure to make one right and one left fuselage side.*



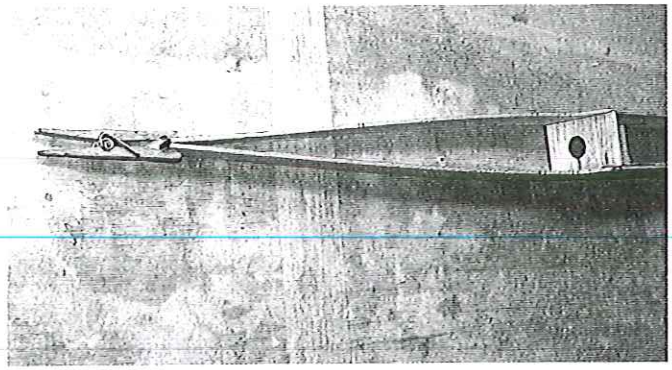
Begin cementing the formers in position on one fuselage side. The triangle helps to keep the formers at a right angle to the fuselage side.



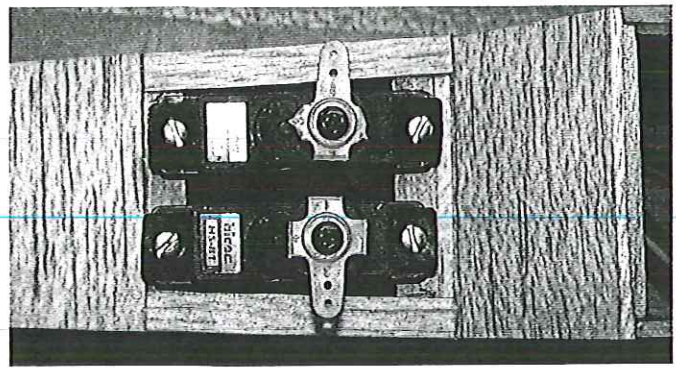
Both fuselage sides are shown cemented to the formers.



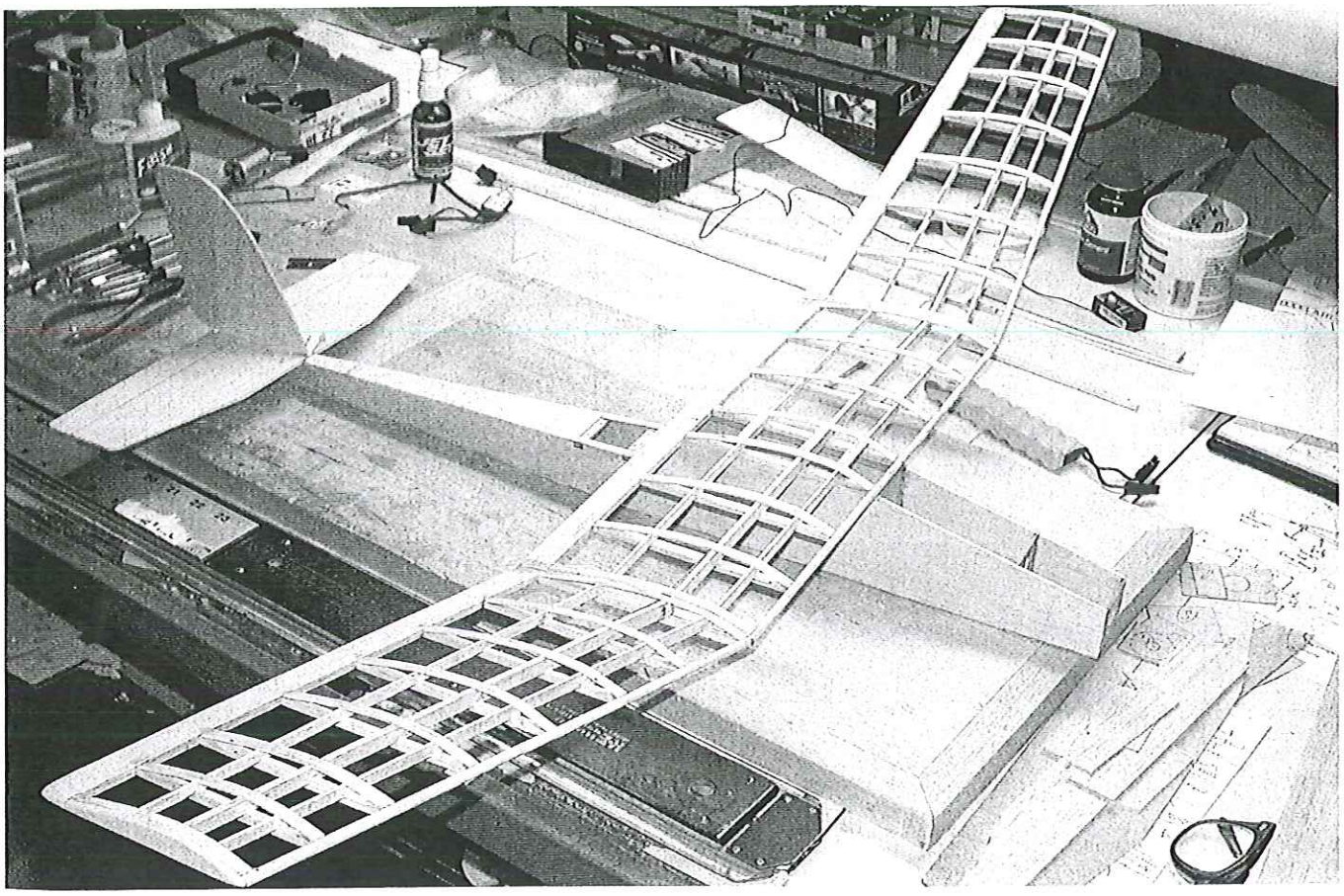
Apply five-minute epoxy to the plywood firewall F1 for extra strength since it supports the electric motor.



Join the fuselage sides at the rear and hold them together with a clothespin until the cement dries.

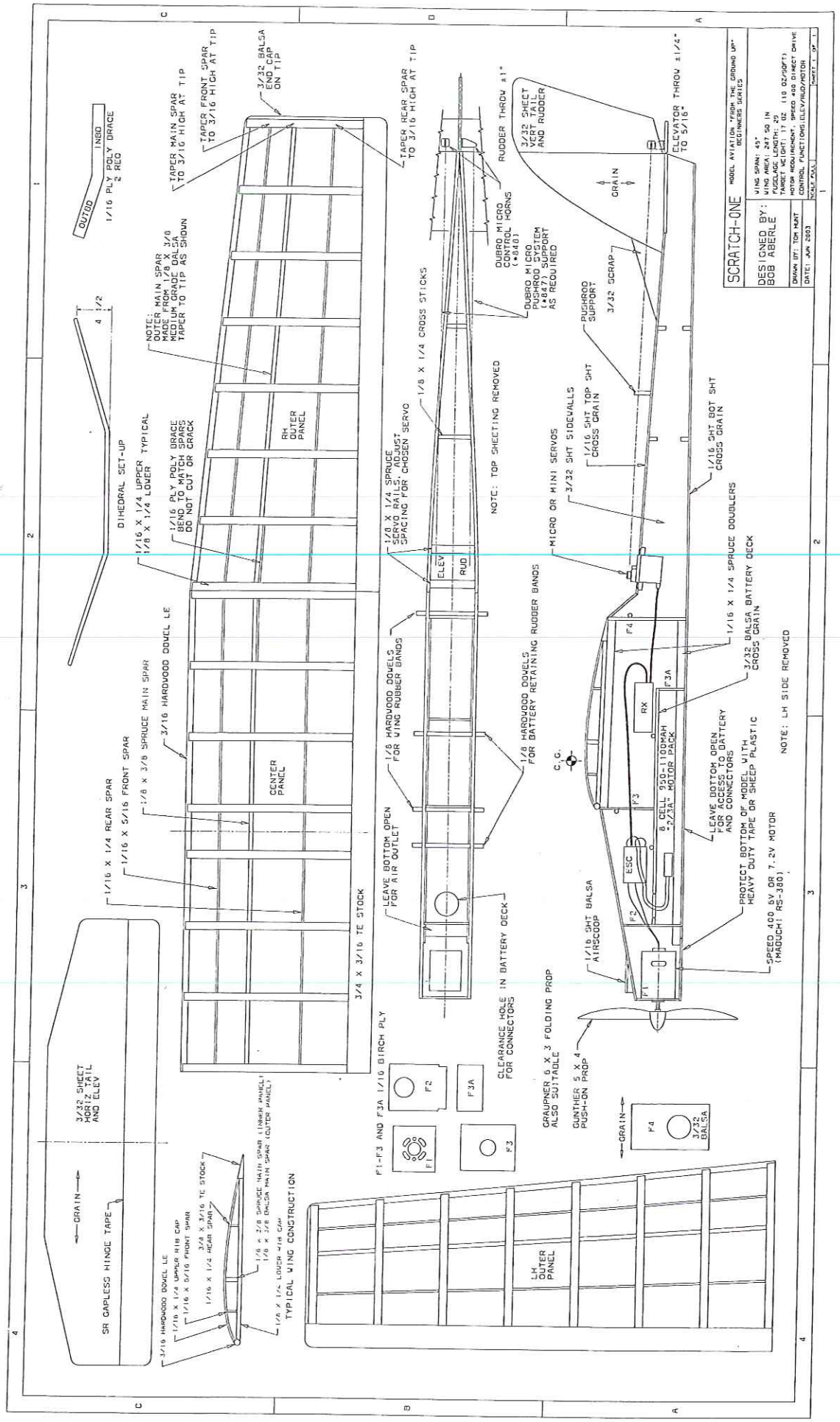


The two Hitec HS-81 servos are in place on top of the fuselage.



The overall framework is pinned together so the author can check everything before covering.

Full-Size Plans Available—see page 175



Building From Scratch

Part Two

from the ground UP

by Bob Aberle

LAST MONTH I took you through the assembly of the Scratch-One up to covering and finishing. This month I'll start Part Two with the covering and take you through the Scratch-One's first flights. The full-size plans were published with Part One in the November issue.

Covering and/or Painting: Whether you want to apply covering or paint is your choice. I opted to completely cover my Scratch-One with Carl Goldberg UltraCote Transparent Lite, which is an easy-to-use iron-on material. The wing must be covered since it is an open structure, so you don't have a choice in that regard.

A good source for learning about applying this material is available from Larry Sribnick of SR Batteries Inc. He has a technical newsletter series called *R/C Techniques* which is available for many hobby-oriented technical subjects. Volume R-13—*Basic Covering Techniques*—details the entire process of applying UltraCote Lite to a model aircraft.

I use two identical irons to apply the UltraCote. I learned that this material shrinks considerably at high temperatures, so I set one iron at approximately 30% power (low heat) and use it to tack the material to the wood surfaces. I set the second iron at roughly 80% power (much higher heat) and use it to make the final adhesion to the balsa surfaces and shrink out the wrinkles on the open bays of the wing. Using two irons it's unnecessary to keep changing the heat setting.

If this is your first time applying covering, be careful to remove the backing from the UltraCote. This will be a paper or a clear material, but it must be separated and peeled away from the covering. You must also realize that only one side of the UltraCote contains the adhesive, which is heat activated. If you try to apply the covering on the reverse side, it will fall off.

For your first time covering, you may want to concentrate only on doing the wing. The fuselage and tail surfaces can make do with a spray coat or two of Krylon clear or color paint.

Hinges: At this point you have a covered or painted fuselage and tail surfaces. These tail pieces have yet to be installed on the rear of the fuselage. This is a good time to add the control-surface hinges for the rudder and elevator.

The simplest technique is to use SR Batteries' Gapless Hinge Tape. It is basically clear, with a strong adhesive on one side. You cut off suitable lengths then press it into position. I usually space the elevator and rudder using a scrap piece of 1/16 balsa at the hinge line and some masking tape to hold it in place temporarily.

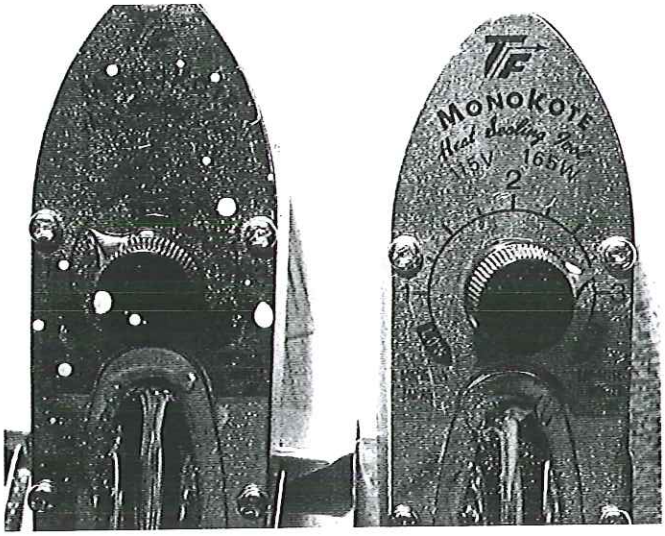
Keep in mind that this hinge material is not fuelproof; therefore, it cannot be used on fuel-powered models (another advantage of electric power!).

Final Assembly: Put the covered or painted stabilizer in position at the rear of the fuselage. If you covered the stabilizer, mark the area where it will mount to the fuselage and remove the covering material from that area. This will allow the cement to adhere properly (wood-to-wood surface). If you opted to paint the stabilizer, mark the area then rough it up a bit with sandpaper. Hold the stabilizer in position and try to eyeball the alignment so that the stabilizer is roughly parallel to the wing center-section. You can place a straightedge on top of the fuselage, in the vicinity of the wing, to help with this alignment.

Once you have it right, add a few pins to hold the stabilizer in position. Quickly

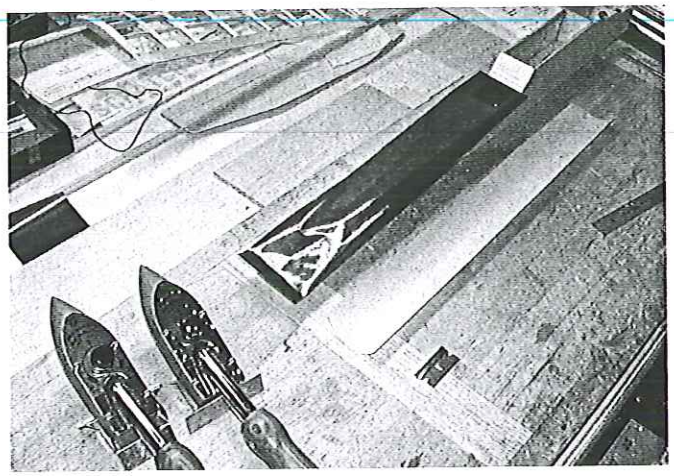
Photos courtesy the author

As text explains, Bob uses two identical heating irons to apply covering.

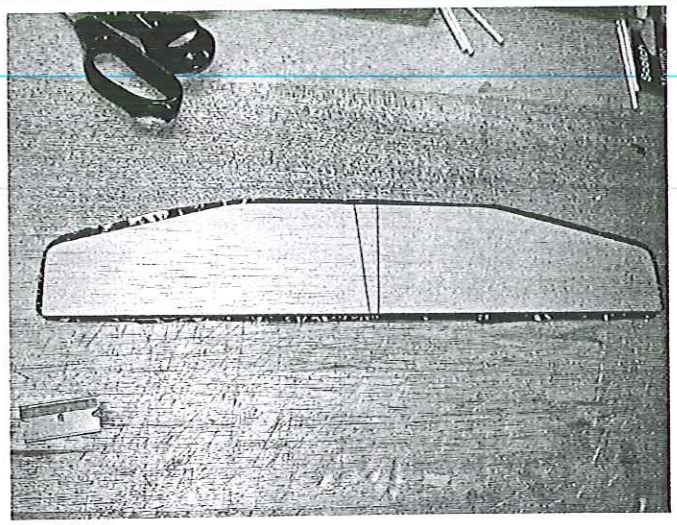


Left iron is set at roughly 30% heat for initial tacking. Right iron is set at 80% of full power for final adhesion of covering to solid wood surfaces and to shrink out wrinkles in wing's open bay areas.

Bob used red and "GELB," which is actually yellow, transparent UltraCote Lite to cover the Scratch-One.



The top of the fuselage is in the process of being covered. You must provide a cutout for the two servos.



One side of the stabilizer has been covered with the edges wrapped around to the other side.

use a few drops of thin cyanoacrylate glue (CyA) to lock everything in place, then follow up with five-minute epoxy.

On top of the stabilizer mark the area where the vertical fin will be installed. Remove the covering from that spot or rough it up with sandpaper if you painted it. Try to eyeball the alignment so that the fin is at right angles to the stabilizer. Pin it in place temporarily, add a few drops of thin CyA, and apply five-minute epoxy.

Now you can finish the upper forward fuselage sheeting. Add an air scoop on top, behind the firewall location. It will allow air to enter and circulate around the motor for cooling purposes. This is important. In the Pogo the motor just "hung out," and air was free to circulate. The Scratch-One has an enclosed fuselage; therefore, you must provide cooling air.

You will also have to cut an air exit hole in the bottom sheeting just in front of former F2. This is also essential for properly cooling the motor. When completed, cover or paint the top forward portion of the fuselage. The motor will then be totally enclosed. If you wanted, you could make an access hatch cover. It is just as easy to remove that top piece of sheeting on the rare occasion when you have to access or change a motor.

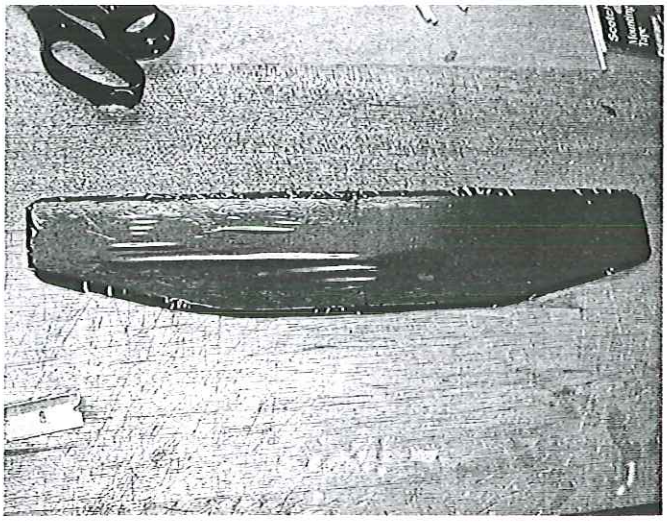
On the forward fuselage bottom, between the firewall and the air exit hole, I added a protective skid. It is a piece of 1/32-inch plastic that is adhered to the fuselage bottom with double-stick tape. This skid will help protect the bottom of the airplane when it's landing.

Now the Hitec Electron 6 receiver can be installed on the top of the battery-compartment floor (under the wing) with double-stick tape. Plug the rudder servo cable into CH1, the elevator servo cable into CH2, and the Electronic Speed Control (ESC) cable into CH3.

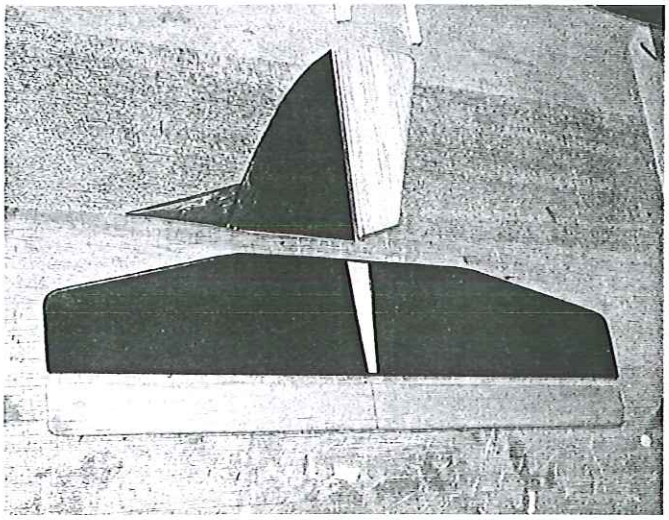
Run the receiver antenna out a hole in the right side of the fuselage, then out to the top of the vertical fin where a small nylon tie keeps it in place. Leave the remainder of the antenna railing off the rear of the model. Under *no* circumstances should you shorten this antenna wire.

Plug in your eight-cell battery. Make sure, for safety purposes, that you don't have the propeller mounted on the motor. Turn on the transmitter, then turn on the Jeti ESC switch. At this point, moving the rudder-control stick on the Neon transmitter should move the rudder servo (left side of fuselage). When moving the elevator-control stick, the elevator servo (right side of fuselage) should move. Moving the throttle-control lever on the rear of the Neon transmitter should turn the motor on and off and vary the speed. Turn off the ESC switch, then turn off the transmitter switch.

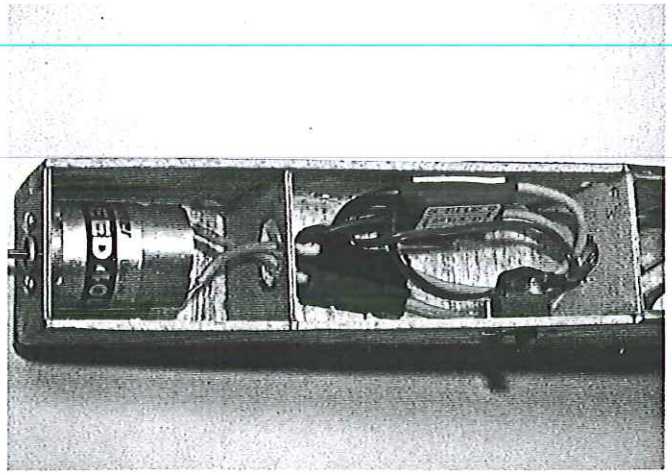
Now it's time to hook up the servo output arms to the control horns on the elevator and rudder at the rear of the model. I



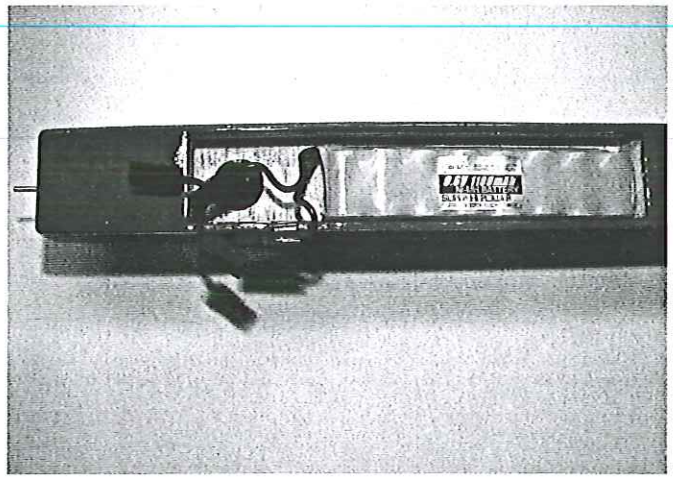
The other side of the stabilizer has been covered, and the edges are wrapped around to the other side. This way there is no joint or seam between the top and bottom halves of the covering.



Covered tail feathers are ready for assembly to fuselage. Bob removed an area of covering from bottom of stabilizer exactly where it will be cemented to fuselage so that cement will make better contact with wood.



Before forward top fuselage is sheeted, install motor, ESC, and switch that is attached to ESC. ESC servo cable passes through hole in former F3 then plugs into CH3 port on Hitec Electron 6 receiver (located under the wing).



The eight-cell 1100 mAh NiMH battery pack goes into compartment on bottom of fuselage. Note position of connectors. Dowels have not been installed yet.

selected the Du-Bro Micro Push Rod System (catalog number 847). It consists of two lengths of .032-inch-diameter wire that slips inside a clear plastic jacket (tubing).

At one end the wire is bent at a right angle. You insert this into the outer hole of a Du-Bro Micro Control Horn (catalog number 848) that has been attached to the rudder and elevator. The wire is held to the control horn with a small E/Z Link Keeper (which is supplied).

At the servo end you must attach the supplied Mini E/Z Connectors to both output arms. These connectors will let you adjust the control-surface positions. Once set, you tighten the screw on top of the connector.

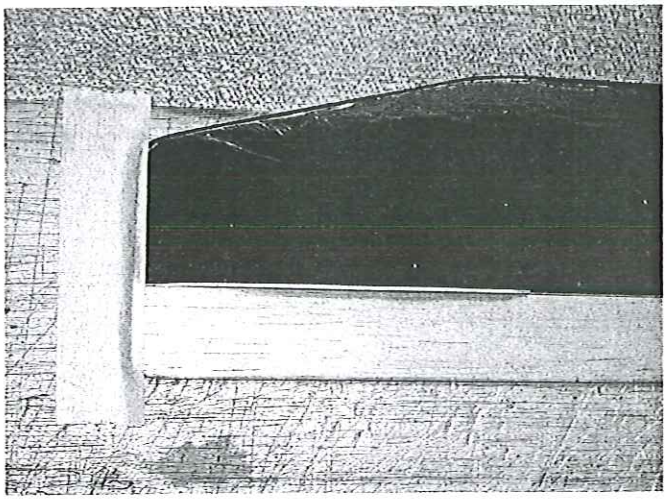
When making that final control-surface adjustment, your transmitter and receiver should be on and the trim levers set at their neutral positions. When moving the control sticks, observe that right is right, up is up, etc. If the controls are backward, open the Neon transmitter case, find the cable for the appropriate channel function, unplug it, rotate it 180°, and plug it back in. Then the control should be in the right direction.

The last item is to place an anchor for the control-rod sleeve approximately halfway between the servos and the control horn. I also made an additional support on the elevator control-rod sleeve in the vicinity of the stabilizer leading edge.

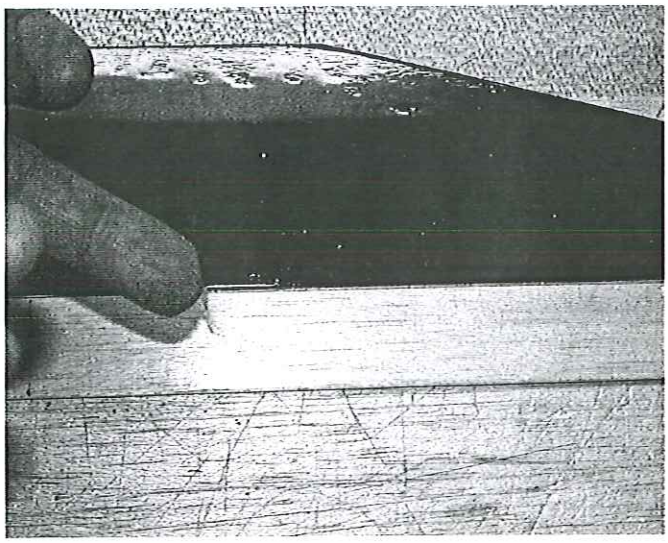
The Du-Bro Mini E/Z Connector supplied with the catalog-number-847 pushrod system is sold separately as Du-Bro catalog number 845. If you order these connectors by number 845, they come with a long and a short mounting pin. To mount the connectors on your servo output arm, you will need the longer pin version. A good source for this Du-Bro hardware is Gabe Baltaian at Air Dynamics ([718] 396-4765 or www.airdyn.com). Also, you will have to drill out (enlarge) the holes on the servo output arm to accept the longer pins of the Du-Bro Mini E/Z Connector.

While you still have everything powered up, it is a good idea to check the amount of control throw for the rudder and the elevator. The rudder movement that worked best for me was ½ inch either side of the neutral position. The elevator movement turned out to be more than I wanted—so much more that it even interfered with the rudder movement. Fortunately the Neon transmitter lets you adjust the amount of elevator control. I was able to reduce the throw to 5/16 inch (either side of neutral), which worked out perfect.

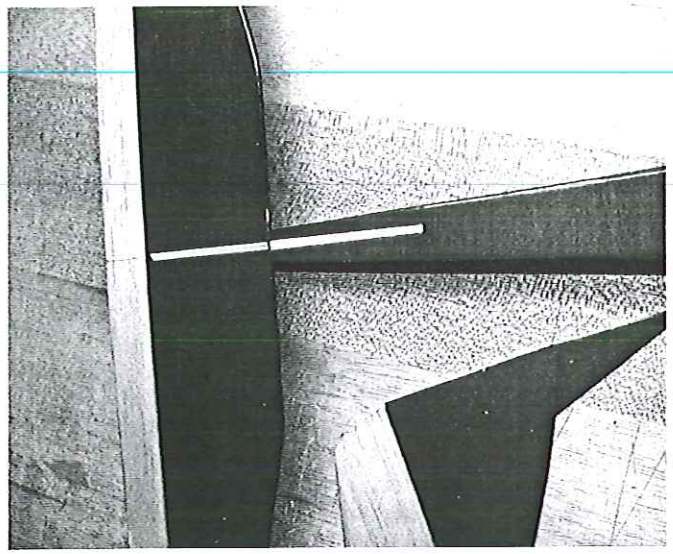
Among the last things to add are the five ⅛-inch-diameter wood dowels; two are used as wing hold-down dowels. I use six No. 33 rubber bands to keep the wing in place. The three other dowels hold the battery pack and connector set in position. Just



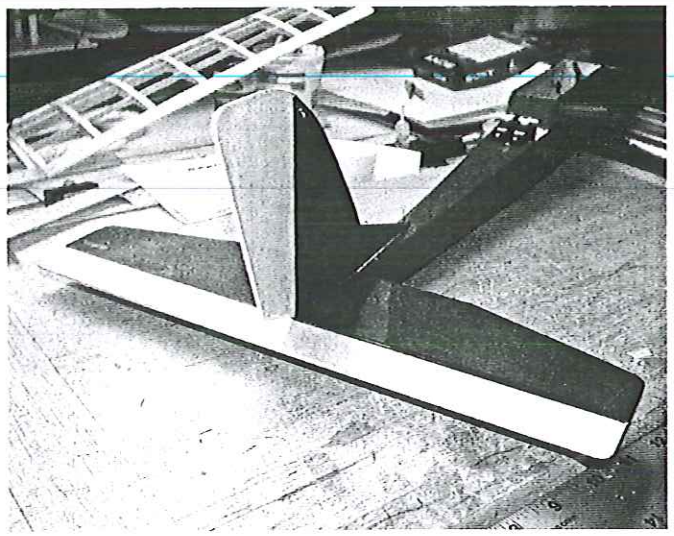
Use masking tape to hold elevator and tab in position while applying SR Batteries' Gapless Hinge Tape. Separate surfaces with 1/16 balsa spacer at hinge line for clearance when surface moves.



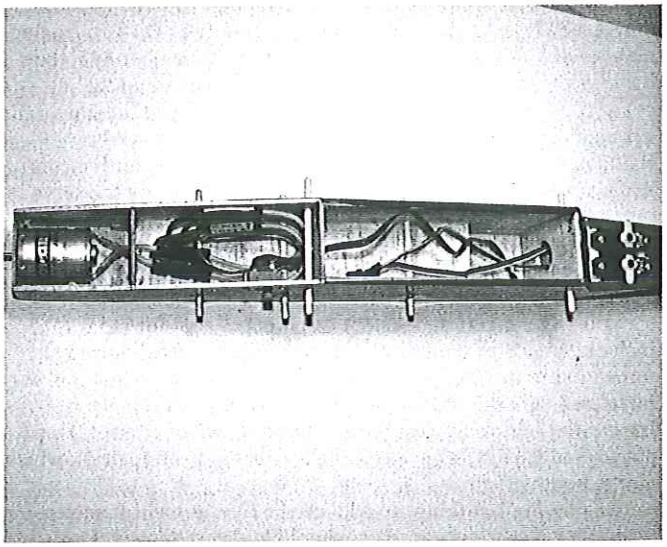
Bob affixes the SR Batteries Gapless Hinge Tape.



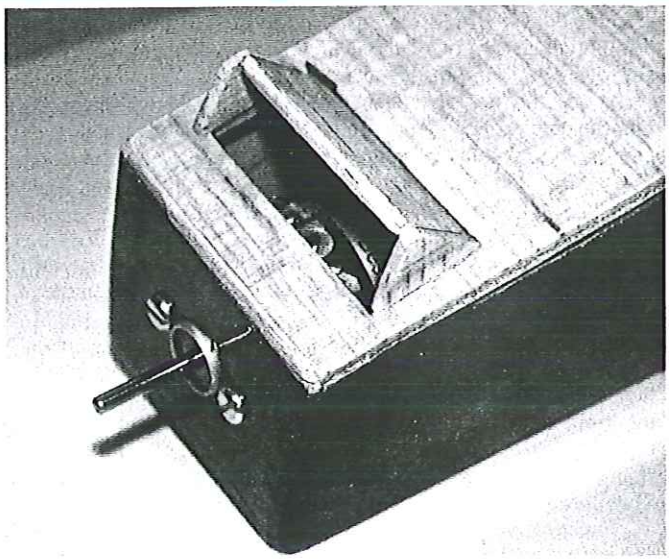
Stabilizer is in place. For better cement adhesion, remove covering where you expect to cement vertical fin.



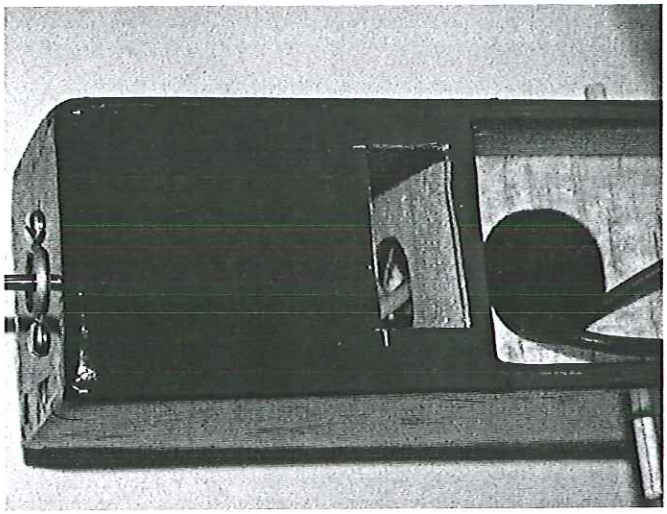
Pin vertical fin in place. Once aligned, tack in place with thin CyA. Follow with five-minute epoxy for added strength.



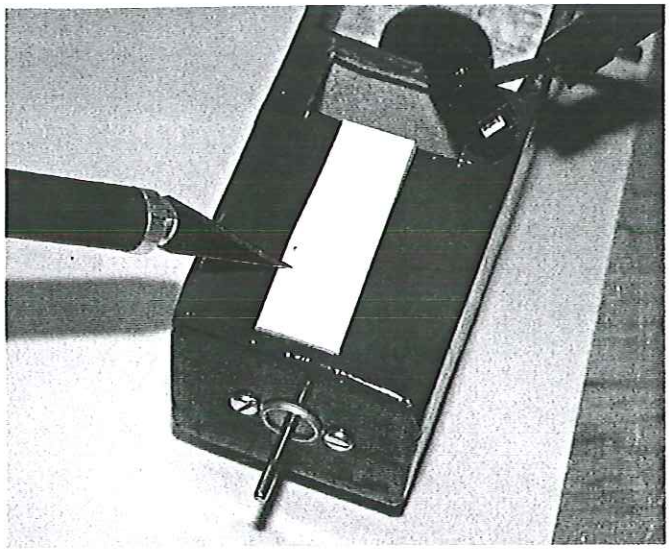
All of the five 1/8-inch-diameter dowels are in place.



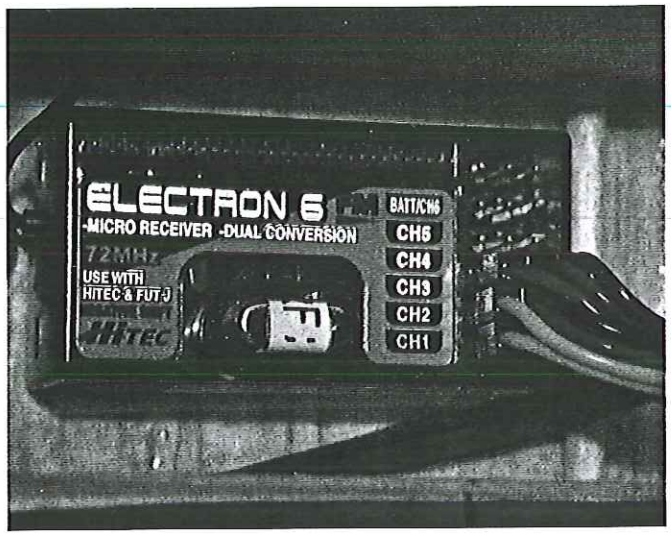
The forward air-scoop intake cools the motor.



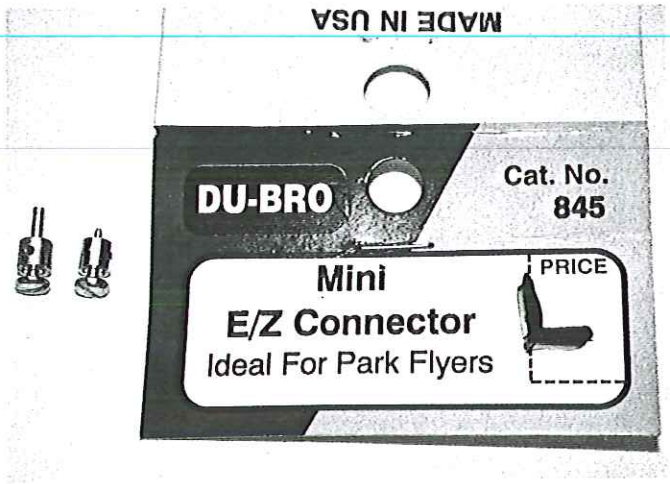
Lower air exit hole passes cooling air outside fuselage.



Front lower skid is made from 1/32 sheet plastic material and held in place with double-stick foam tape.



Hitec Electron 6 receiver in position on top of battery floor. CH1 is rudder servo port. CH2 is for elevator. CH3 (although it doesn't look it) is for ESC cable for throttle purposes.



Du-Bro's Mini E/Z Connectors (at left) come in long- and short-pin versions. Make sure you get the longer version.

insert each dowel, apply a small amount of thin CyA, and follow with a light spray of accelerator.

The battery pack is held in place with several No. 33 rubber bands. It is easy to remove for charging purposes or to swap with a freshly charged battery pack. You can do this without removing the wing.

It is a good idea to unplug the battery when you're not flying. That's a general safety tip for electric-powered models. I also learned that even with the Jeti switch turned off, some power is still consumed and that will run the battery down in only a day or two. That's another reason to unplug the battery.

Final Balance: The center-of-gravity (CG) point on the plans is the typical 25% back from the wing leading edge. The Scratch-One balanced perfectly with everything as shown on the plans. If for any reason you end up nose- or tail-heavy, just reposition the battery to achieve the correct balance.

Motor/Battery Parameters: Motor current will average 10-12 amps on the eight-cell 1100 mAh NiMH battery pack. The rpm is 13,900 with the Gunther 5 x 4 propeller. Power to the motor is 90 watts. The calculated motor run time at full throttle is roughly six minutes, but at reduced throttle settings you could expect up to roughly 10 minutes.

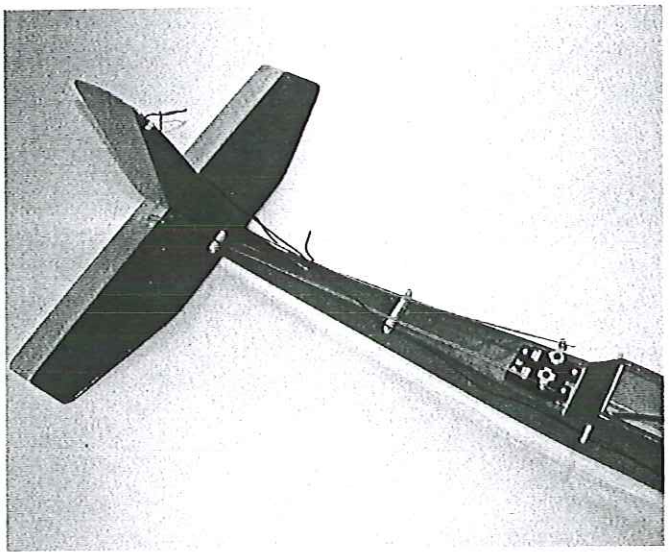
Flying: Flying the Scratch-One was much the same as flying the Aero Craft Pogo, which was described in the September 2003 installment of "From the Ground Up." Since the Scratch-One has no landing gear, it is always going to be hand launched.

Although it's an ounce heavier than the Pogo and using the same power system, the Scratch-One seems faster in the air. That makes it easy to throttle back, thereby reducing the motor current and increasing flight time. I normally get 10-minute motor-run time with a lot of throttling back. On many occasions I've caught a thermal and increased my flight time to almost 15 minutes. The more time the model can stay in the air, the faster you are going to learn to fly.

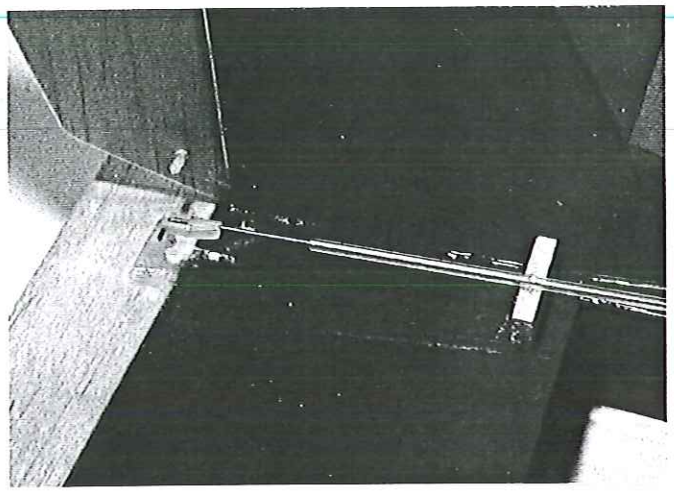
Landings are slow with power throttled back or turned off, giving the beginner a chance to line up and judge distances properly. This airplane just doesn't have any bad habits.

I have been using the same Gunther 5 x 4 propeller on the Scratch-One. Without a landing gear I suspect that a propeller will get broken every once in awhile. In colder weather the plastic propellers can become much more brittle. If that is the case I recommend using a folding propeller assembly such as the Graupner 6 x 3, which can be obtained from Hobby Lobby.

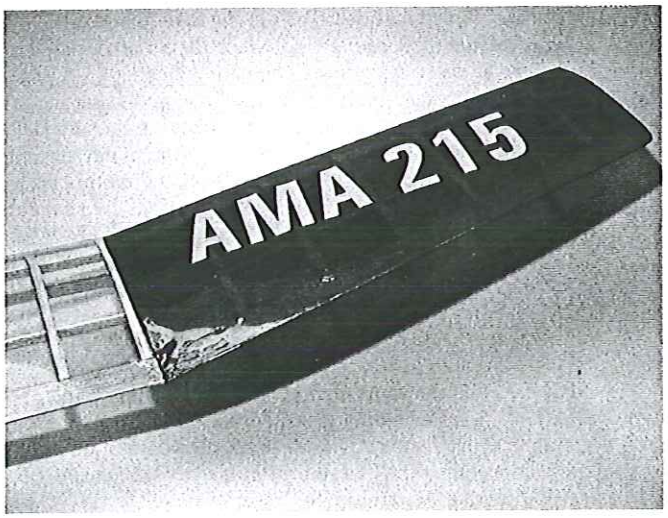
Motor and Radio Control System (RC) Reference: The RC system and the electric-power-system components were



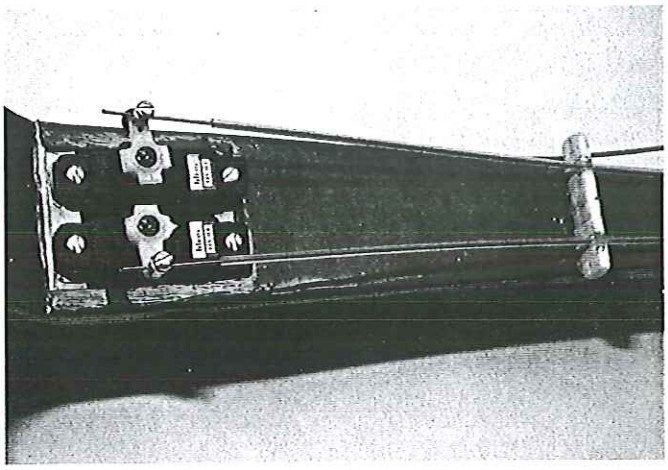
Control rods run from servo output arms back to control surfaces. They were left exposed to make installation easier for beginners.



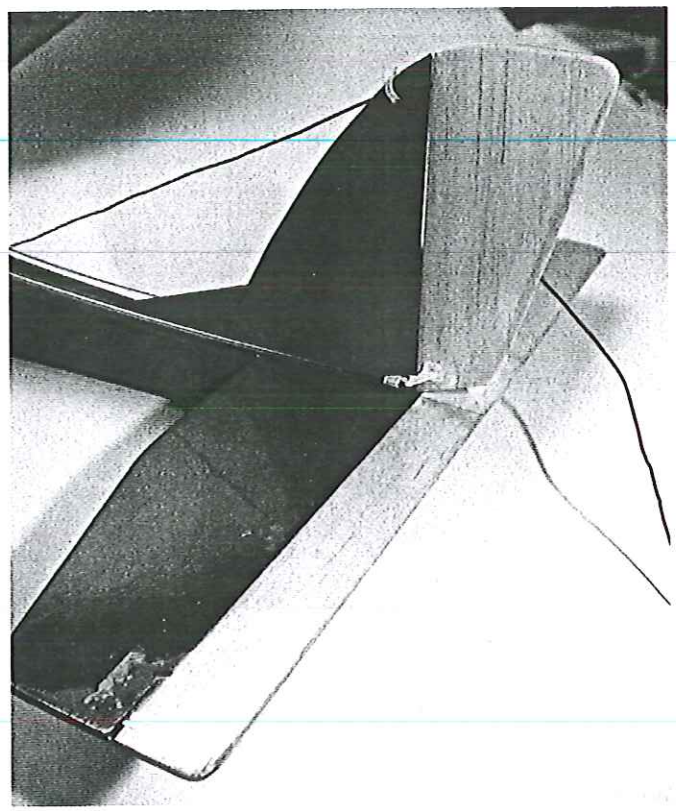
Du-Bro Micro Control Horns and keepers hold wire control rods in place. Wire moves inside clear plastic tubing.



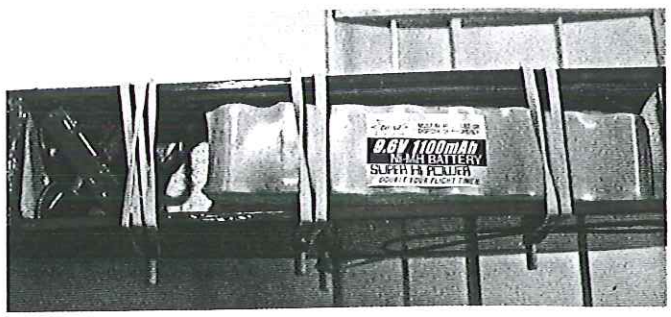
Bob's three-digit AMA number on top of wing reflects 50-plus years as AMA member and induction into Model Aviation Hall of Fame.



Du-Bro Mini E/Z Connectors on servo output arms (outer holes) make control adjustments extremely easy.



Receiver antenna is attached to top of vertical fin with help of small nylon tie. Do not cut off excess antenna wire!

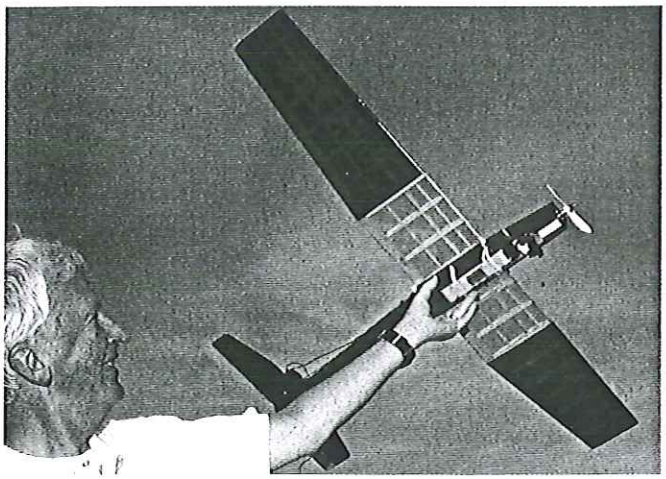


Wing stays in place. Battery pack is accessed for charging or swapping from bottom of fuselage. Rubber bands hold it in position.

The model is in the air. All of Bob's hard work paid off.

Bob makes a low pass with the Scratch-One. His buddy Tom Hunt is on the digital camera.

Bob is ready to fly the Scratch-One at his home field on the east end of Long Island in the town of Calverton.



Bob holds the model so you can see the underside.

previously described in this series. Rather than duplicate all of that data, I will list the "From the Ground Up" articles published in *Model Aviation.* You can also find them on the AMA/*Model Aviation* Web site (http://modelaircraft.org/mag/index.htm).

The electric power system was described in the July 2003 "Introduction to Electric Power" installment starting on page 56. The Hitec RC system was described in April 2003's "Radio Control Systems—the Real Basics," page 54, and in May's "Radio Control System Installation," page 24. Further information was published in June 2003's "Radio Control System Operation" installment, page 46. A product review of the Hitec Neon system was published in the September 2003 issue. MA

Bob Aberle