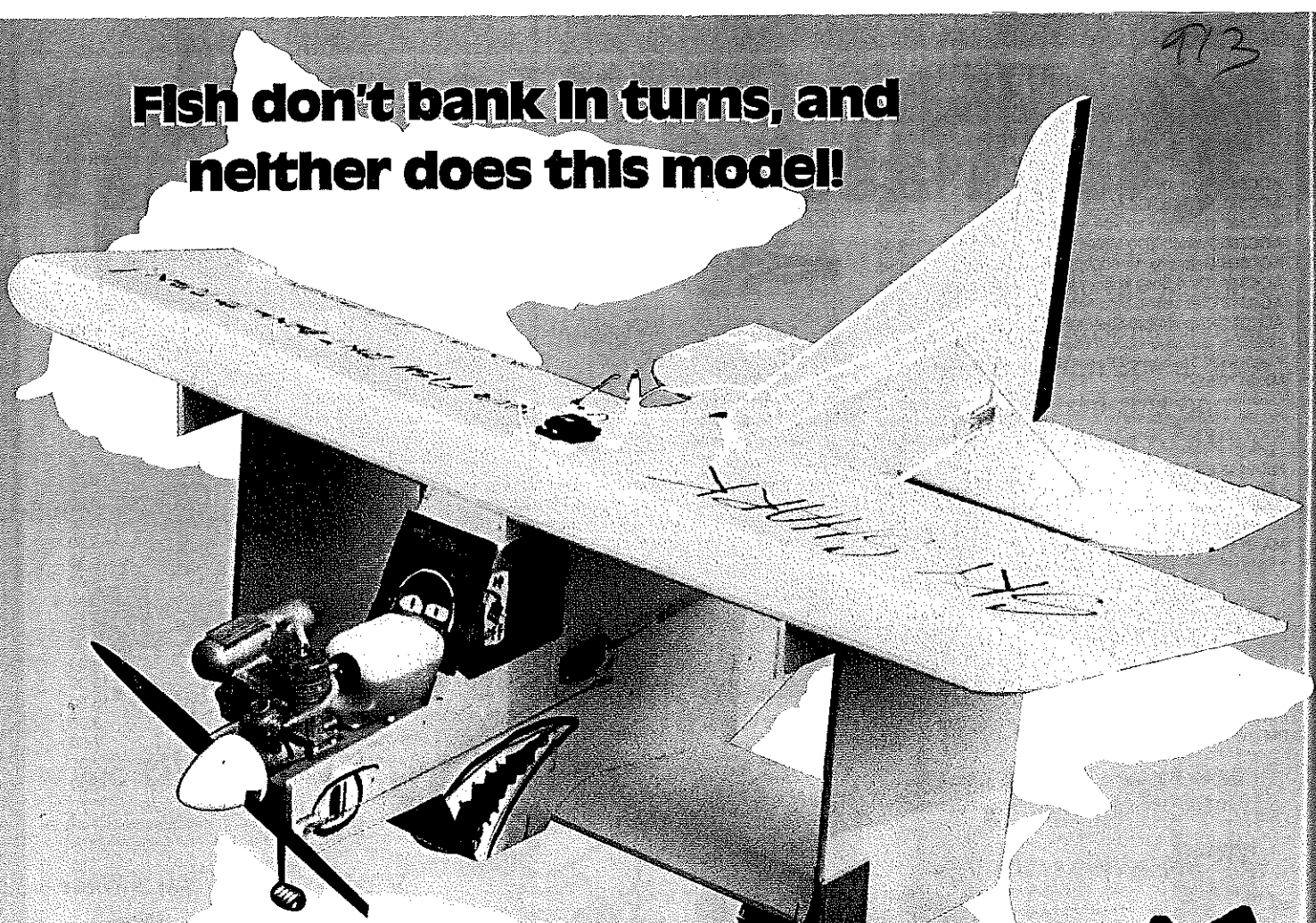
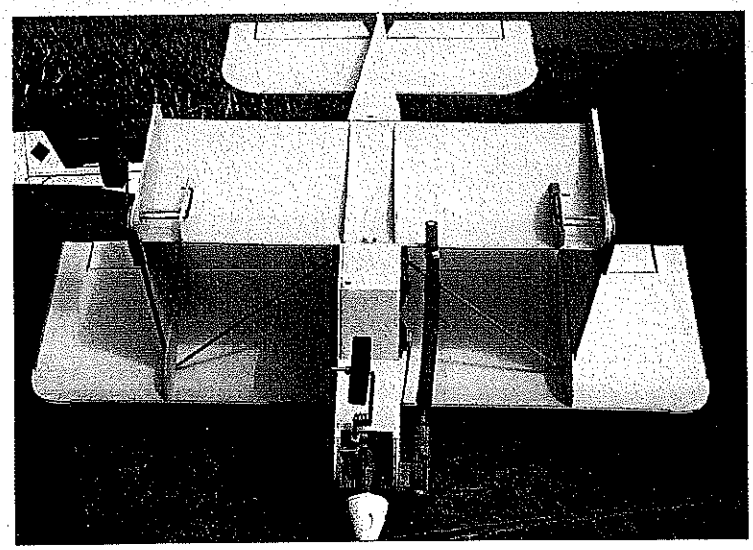
Fish don't bank in turns, and neither does this model!



SKY SHARK

■ John Hunton with Seena Vasan



The bottom of the Sky Shark shows deeply cambered wings for maximum lift. The model will seem to hover in a slight breeze.

THE CONCEPT of using vertical lifting surfaces to provide a sideward force is not new. Controllable vertical wings have been used to counter crosswinds in an experimental full-scale airplane. Auxiliary wings have been used on jet fighters to improve tracking for gunnery. Side-force generators were used during the 1970s in Remotely Piloted Vehicles (RPVs) to improve terminal guidance.

A benefit of using vertical wings, which may not have really been tapped until now, is flight-control simplification.

The availability of economical autopilots has made it possible to couple a simple wing leveler with side-force to make a Radio Control (RC) model that does not have to bank to turn, and is therefore intuitive to fly.

The Sky Shark has been tested by beginners of all types, young and old, male and female, with complete success.

With the Sky Shark principal, beginners can be told a few simple things and fly right off.

These are the things they should be told: With no control inputs at all, this model will fly level and straight ahead. Pull the right lever to go up; push it to go down. Tilt the same lever to the left to turn left; tilt it to the right to turn right. Push the left lever to go faster (higher), and pull it to go slower (down).

That is all, except to understand that all control inputs should be minimal and gentle. Never go wall-to-wall.

With a conventional model airplane, which must bank to turn, the beginner has to contend with the "graveyard spiral" syndrome. The novice will tend to hold control into a turn until the model spirals from the sky.

The Sky Shark does not bank to turn. Its wings stay level all the time; therefore, it turns in the air like a car turns on the ground—so anyone who can control a car can understand how to fly the Sky Shark.

Another problem with the conventional model is that the pilot must be able to see to what degree the wings are banked to control it properly. If an RC model gets out of visual range and the pilot cannot see how the wings are tilted, control will be lost and the model will probably be doomed.

With the Sky Shark, as long as you can see a speck in the sky you will be able to steer the model.

It is hoped that this novel design will provide a new and much simpler way for the beginner to successfully experience the joy of RC model flying.

It is also hoped that this model will provide a stepping-stone for those many potential pilots who see an RC model flying, think it will be easy to fly, try it, and get completely discouraged by how difficult it really is.

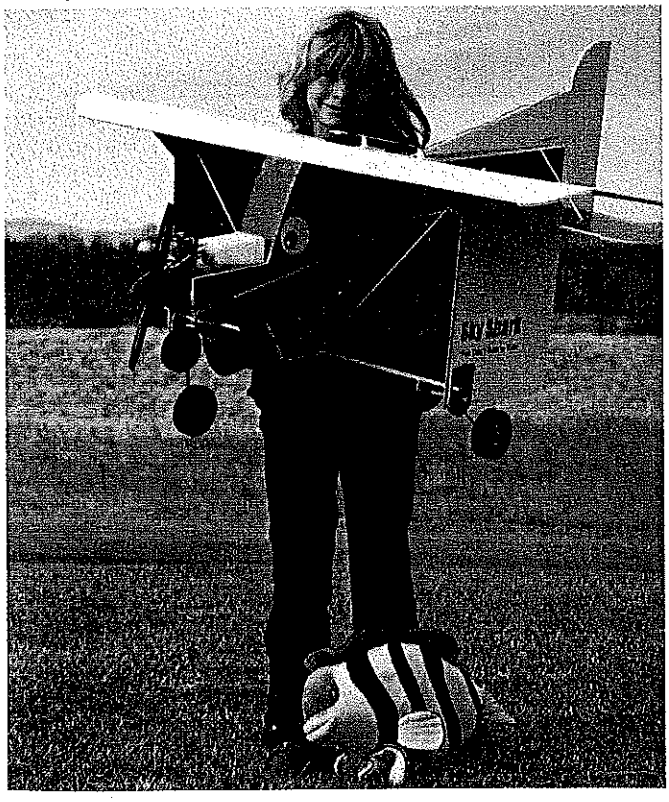
The turn-without-banking concept has been around for a while. (See "The Fabulous X-Wind" in the March 1991 *Model Aviation*.) When Seena Vasan, a raw beginner who flew successfully with Sky Shark the first time, began to understand the design principles behind the Sky Shark concept, he saw what it could do for entry-level model aviation.

Seena wanted to bring it to the public. So with his encouragement and support, here it is.

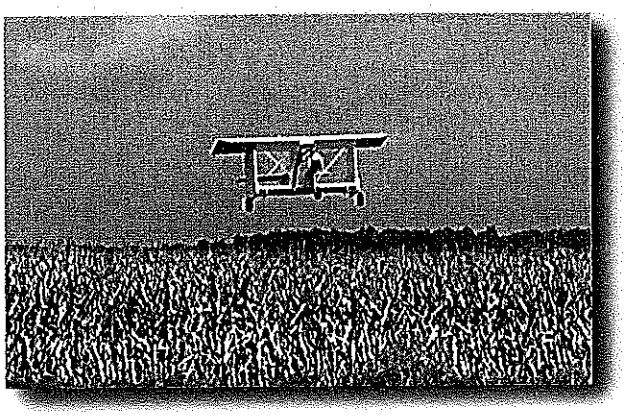
Even though this model will provide the first-time pilot the best chance to fly of any RC aircraft model I have ever seen, I strongly advise against trying to fly it without experienced help.

Take your model to an established RC field and have an experienced pilot check it out for you. But don't let that person fly it without asking him or her to read the instructions and understand the

Photos by Seena Vasan, except as noted Graphic Design by Carla Kunz



Designer's granddaughter Katie is eight. She hasn't performed a landing yet, but can easily fly Sky Shark! Vince Tabacco photo.



Autopilot

The Sky Shark is an inherently stable airplane; therefore, any time it is turning, it is trying to bank into the turn. We want the Sky Shark's wings to stay relatively level to the ground at all times.

"Rate"-type gyro autopilots do not seem to be able to make long-term corrections. They tend to give up quickly in a turn, and let the model bank. Our best results have come from using an optical autopilot: the Futaba PA-2.

This autopilot works very well within its limitations. Read the instructions that come with the unit, and completely understand the limitations.

If you understand that the PA-2 depends on the color contrast between the sky (light) and the ground (dark), you will understand why the optical system will not work well over white snow, when the sun is very low, or in fog.

However, the PA-2 can be overridden at any sensitivity setting with control-stick motions, so marginal conditions do not present a hazard to the model if you are experienced at flying it.

Check that the autopilot (Futaba PA-2 recommended) works in the proper direction by tilting the model under the sun or a strong light. If the model is tilted to the left, the left aileron should go down to restore wings-level. If the model is tilted up, the elevator should move down.

During tests we have positioned the PA-2 on the Sky Shark in several locations: on top, on the bottom, and in the middle. The best results have been with the system mounted in the fuselage with the mode set at "X."

The PA-2 comes from the factory set at the "+" mode, where the sensor looks directly front and back and directly side to side. The PA-2 will not work mounted in the Sky Shark fuselage at the + setting.

With the mode changed to X, the sensor looks out of the airplane at 45° front and back and to the sides. With the sensor mounted in the fuselage, it is well protected from the sun at oblique angles and it works well.

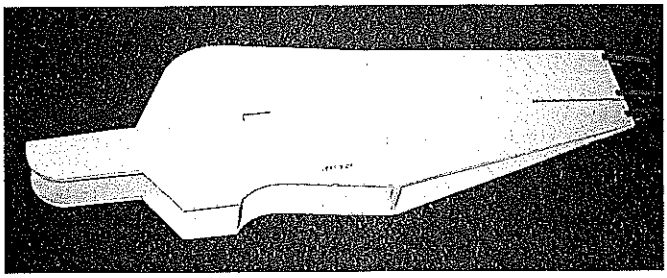
We suggest positioning the control module so that you can get to the sensitivity screw from outside the model. Make first flights at full sensitivity (fully clockwise), and back off of that (counterclockwise) as you want to transist toward normal RC flight-control modes.

The PA-2 provides two axes of stabilization: roll and pitch. Although the theory of this model works well with only roll stabilization, using pitch-stability augmentation adds another magnitude of control simplification.

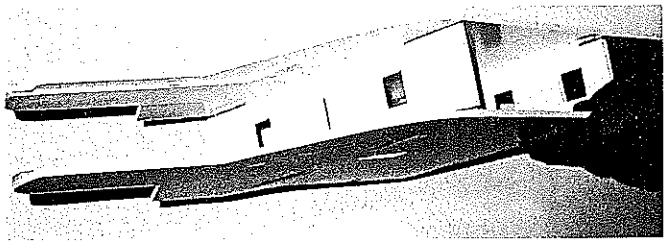
With pitch and roll stabilized, a trimmed Sky Shark will automatically and promptly return to straight-ahead and wings-level flight from any attitude if the controls are neutralized.

Pitch stabilization also helps greatly in landings; just reduce power, and the model will descend on its own to land. MA

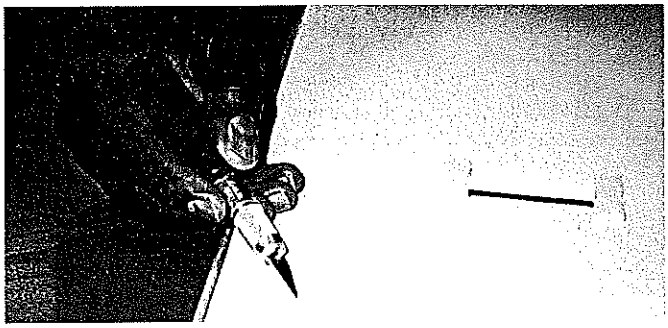
—John Hunton



Fuselage sides are joined with the formers, and the tail section has been pulled together and glued. Note former notches.

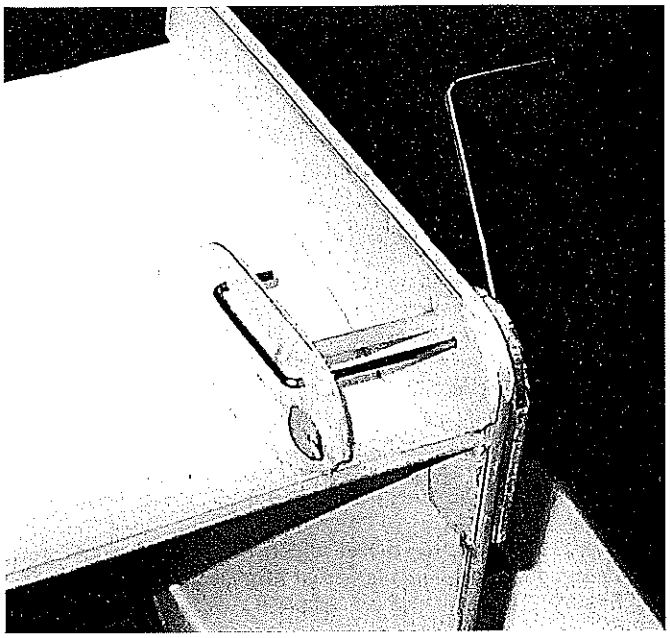


You can see the plywood doubler plates for the engine mount installed on the fuselage sides. Also note the formers.

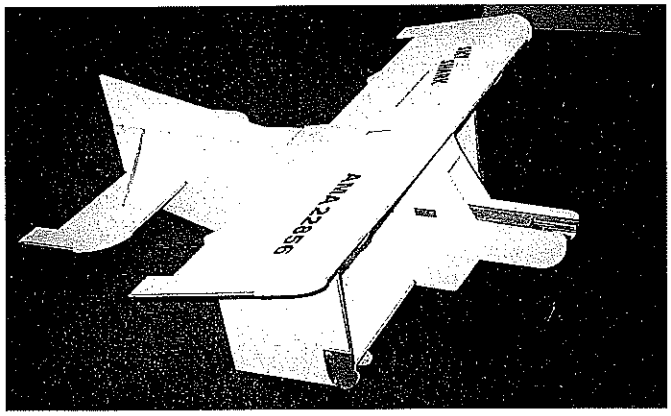


Make several slices along the leading edges of the curved surfaces. Slices are made at 45°, to facilitate bending.

Mohammed Abdelrahim with assembled lower wing. It has been curved, then stabilized with wing ribs. Joined unit is very strong!



Landing-gear design is a triple-torque type, capable of taking large landing loads. Assembly sequence is critical; see text.



The completed airframe has a distinctive shape! The model is rugged and should last a long time with routine maintenance.

SKY SHARK

Type: RC trainer and sport

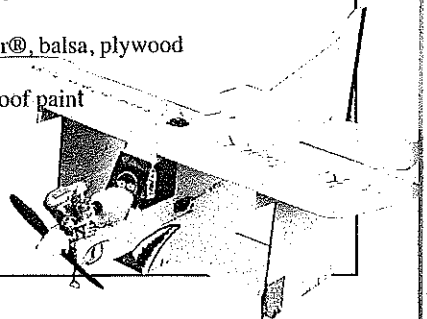
Wingspan: 40 inches

Engine: .40 two-stroke

Flying weight: 48 ounces

Construction: Fome-Cor®, balsa, plywood

Covering/finish: Fuelproof paint



principles; he or she might have a more-difficult time flying the Sky Shark than you would.

CONSTRUCTION

Sky Shark is simple and inexpensive to construct with basic building materials available at any department store: Fome-Cor® and Elmer's® glue. Dig in and have fun—especially if you have not built this way before.

Note that the Sky Shark's wings are not removable. It is a very compact model, and it fits into most subcompact cars fully assembled.

Assembly: Lightly spray with adhesive the backs of the paper templates provided, and adhere them to foam board and plywood.

Lay the foam board over a soft cutting surface. Cut out all parts with a sharp X-Acto™ blade (number 11 is recommended), but do not cut the ailerons or elevators free yet.

After you make all cuts from one side, turn the foam board over and check all corners, and cut clean as necessary. Identify all foam-board parts by labeling them.

With a black felt-tipped pen, add any markings you would like, including your AMA number on the top wing. (Some Sky Shark prototypes have been built using 20- x 30-inch colored board; that requires joining the top wing in the middle.)

The fuselage sides are bent slightly at the rear former. Depress the inner skin along the rear former position with a coin along a straightedge. Make the slight rear fuselage bends.

Install the plywood fuselage side doublers and all servo-reinforcement plates on the inside, including at the underside of the top wing. Lay the fuselage sides down on plywood, face to face, and weight them to prevent any warping while the glue dries completely.

Cut out all plywood parts and sand any fuzz off of them. Glue the three engine-mount parts together, leaving a 1/4-inch gap for the firewall.

On the wing blanks, mark out the cuts 1/2-inch apart under the wing leading edges. The top wing gets six cuts and the lower wing gets five. Tilt the knife toward the leading edge of the wing at roughly 45° while cutting. Don't cut through to the top (opposite) side of the foam board.

To prepare for gluing dowels to the leading edges of the wings, etc., precut several 1 1/2-inch strips of clear tape and mark regularly spaced positions for the tape to be installed. Once this tape is pressed on, it cannot be removed without tearing paper.

Use five positions for the top wing, three for the bottom wing, and two or three each for other surfaces. Glue all the 3/16 leading-edge dowels in place, then set the panels aside to dry thoroughly.

Sometime when you have nothing better to do, reglue the dowels top and bottom to prevent fuel seepage under the paper.

When the servo plates are dry, predrill for the servo screws. When the engine-mount parts are dry, drill for your motor and install the blind nuts.

Taper one side of the fuselage at the rear joint, so only one full thickness of foam board will be available for inserting rudder hinges. Install both fuselage formers, noting top from bottom and front from rear.

Square the formers accurately using a scrap of foam board as a square. When dry, pull the rear fuselage sides together and glue and clamp them, checking for accurate vertical alignment.

Beginning with the lower wing, then following the same steps with the top wing, prebend the curvature of the leading edge by placing the panel on a bench, top side-down and cut side-up.

Pull up on the leading-edge dowel and press into the underside with thumbs until an approximation of the final curve can be developed by pulling the leading edge up.

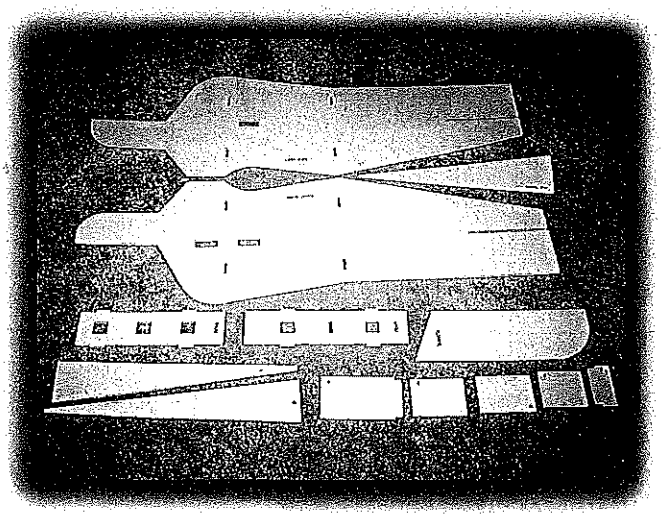
Place your tape dispenser a distance from the edge of your bench that is equal to the wing chord plus two inches. Precut the number of tape strips you will need. Set these strips aside in a handy place.

Work white glue into the wing leading-edge slits with a scrap of foam board. Starting in the center of the wing panel, press a piece of tape tightly around the leading-edge dowel and onto the upper surface of the wing by one inch.

Pull the tape tightly toward the trailing edge to form the required

Continued on page 35

Working with Fome-Cor®



Fome-Cor® builds quickly in large areas with easy-to-use and inexpensive aliphatic resin (Elmer's® glue). A few tips will help you build quicker and neater.

Make cuts over a soft surface to keep your blade sharp. Keep the blade sharp to prevent tearing the bottom paper surface. Use an X-Acto™ knife, and keep it vertical when cutting.

Use a metal straightedge, whenever possible, to run your blade along. Only cut through the top paper layer on your first pass, then follow up with a deep, thorough cut.

Keep a rag or tissue nearby when gluing, to keep your fingers clean.

Use clear tape and clothespins to hold parts in place. Never remove tape that has adhered to a finished paper surface.

You can use water-based fillers, but do not touch the finished paper surface with the grit when sanding. You can easily sand Fome-Cor® board edges for a good fit.

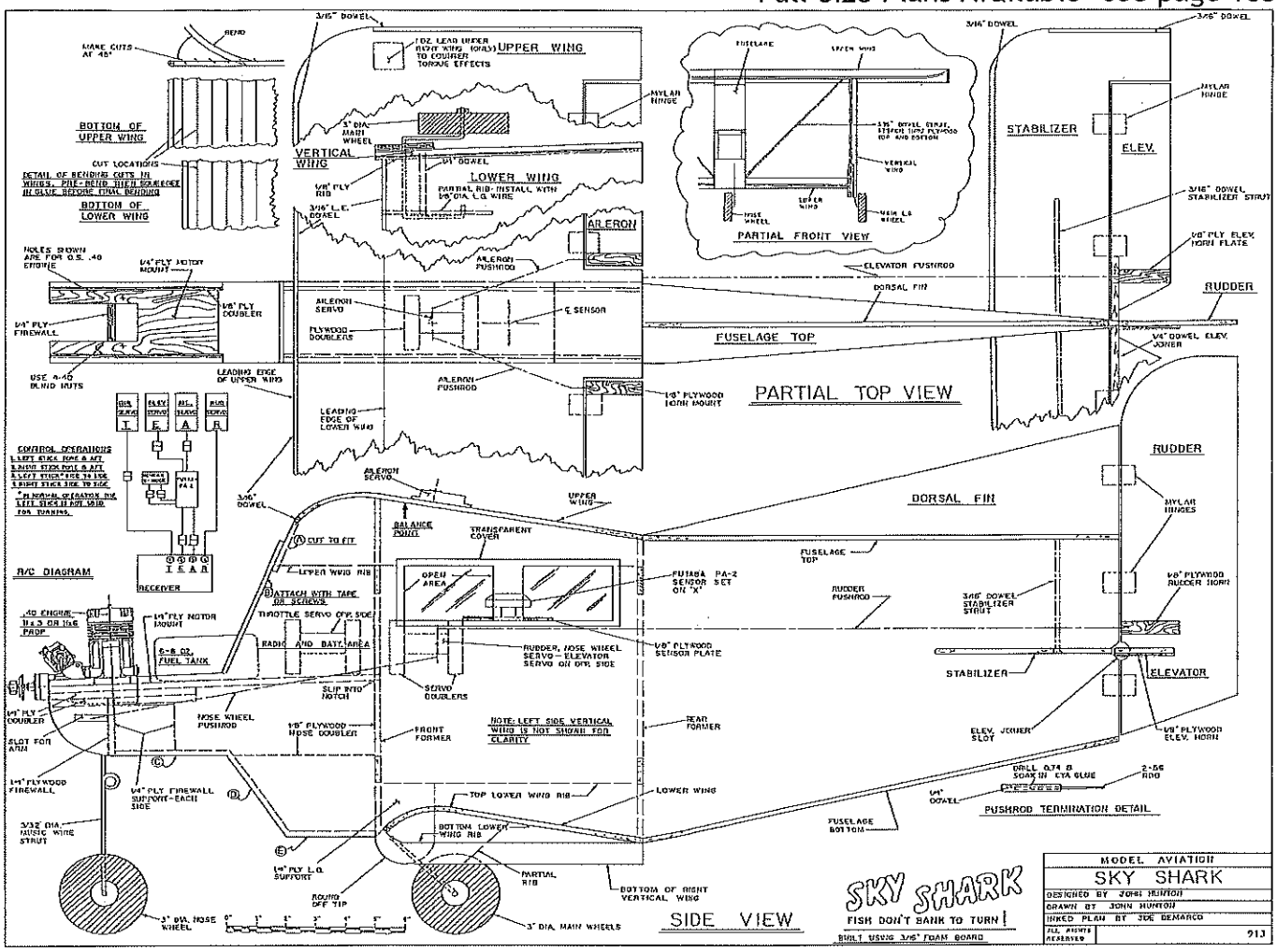
If a Fome-Cor® area gets roughed up, cut it out and insert a new piece, which can be glued in. Epoxy can be used in critical areas, but test other glues on scraps before using.

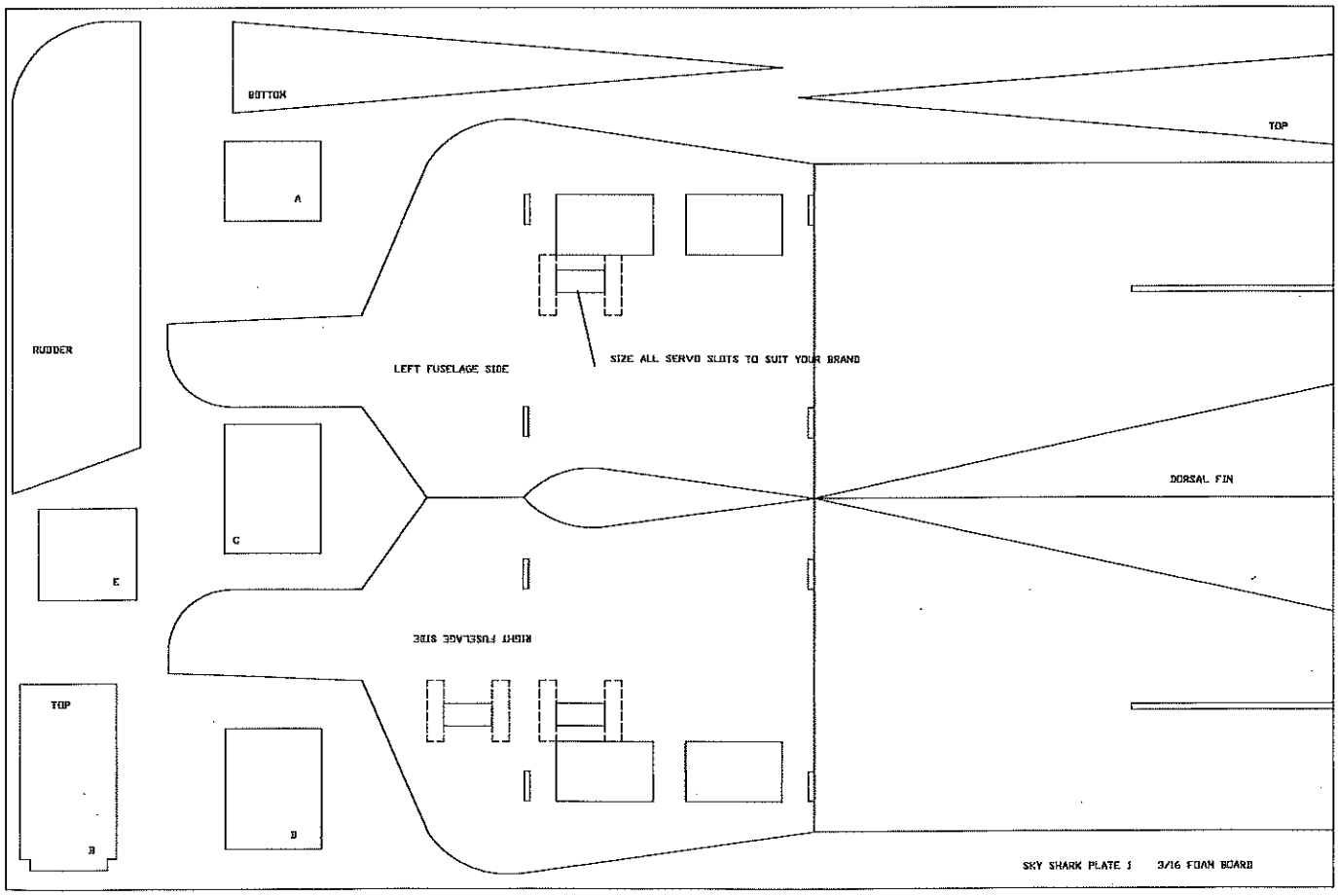
Rust-Oleum® in a spray can works well for painting.

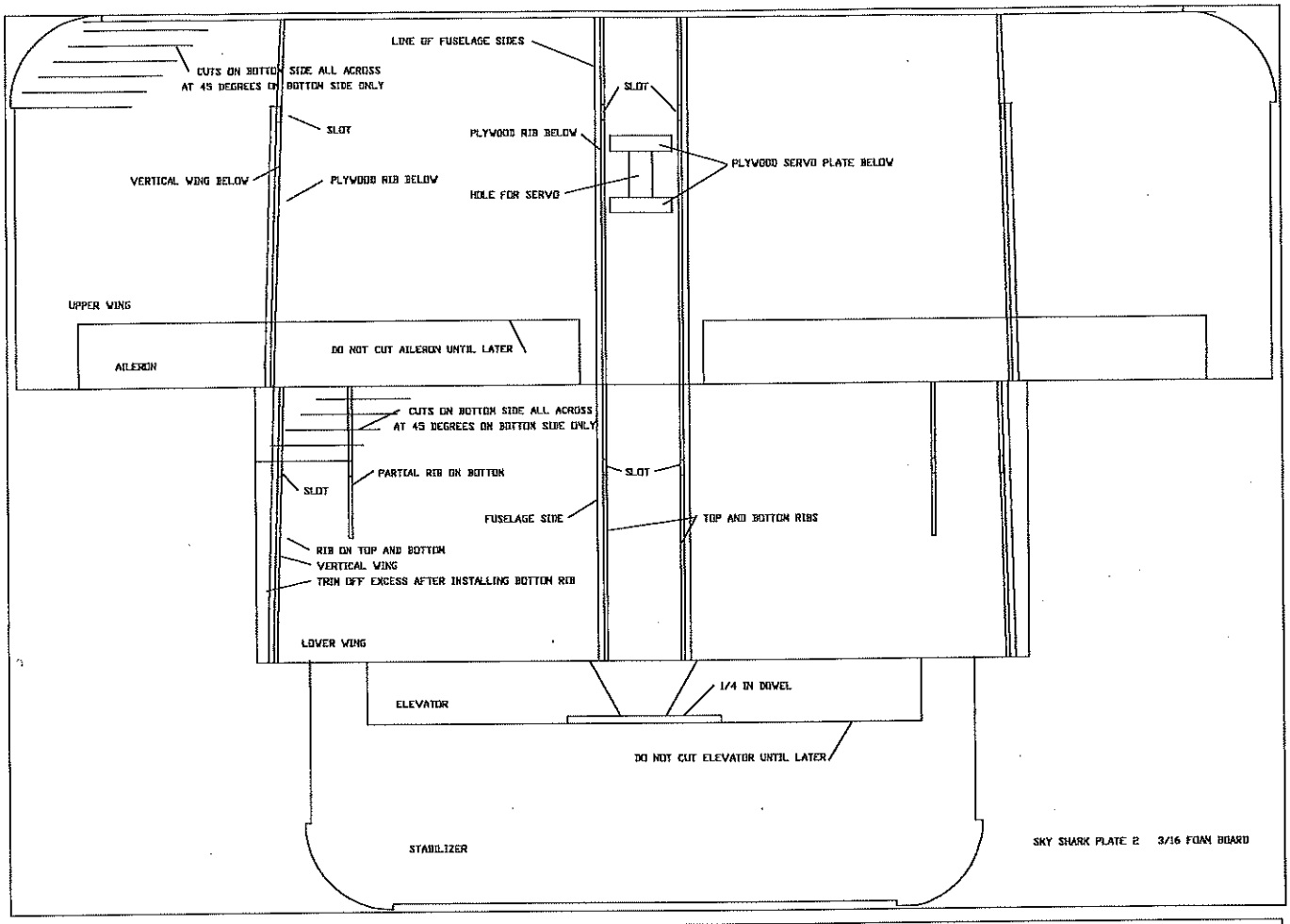
If you use colored Fome-Cor®, use clear polyurethane spray for a final clear protective coating. 21st Century® High Gloss paints work very well, are fuelproof, and give a good colored finish.

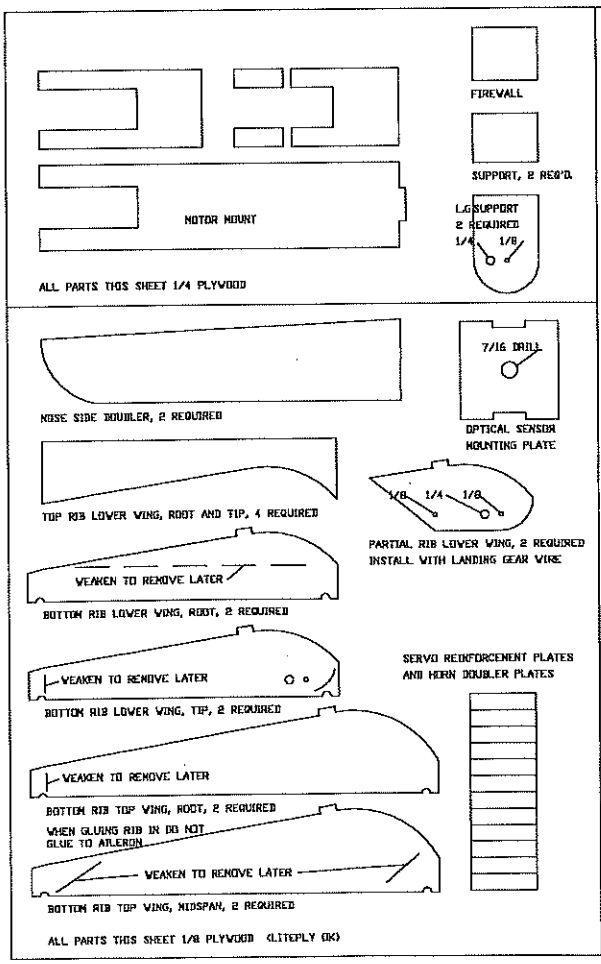
Do not use water-based detergents for cleanup; use rubbing alcohol. MA

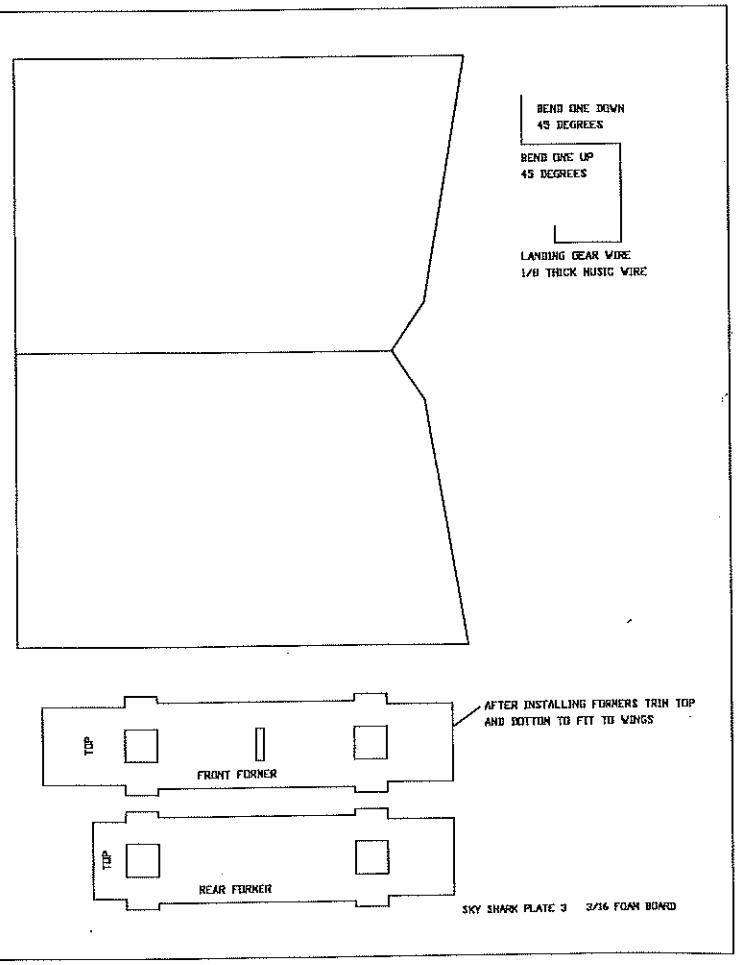
—John Hunton


UPPER WING
LOWER WING
VERTICAL WING
AILERON
PARTIAL FRONT VIEW
STABILIZER
ELEV.
RUDDER
FUSELAGE TOP
PARTIAL TOP VIEW
DORSAL FIN
R/C DIAGRAM
RECEIVER
FUSELAGE BOTTOM
PUSHROD TERMINATION DETAIL
SIDE VIEW
SKY SHARK
FISH DON'T BANK TO TURN!
BUILT USING 3/16" FOAM BOARD
MODEL AVIATION
SKY SHARK
DESIGNED BY JOHN HUNTON
DRAWN BY JOHN HUNTON
INKED PLAN BY JOE DEMARCO
913


BOTTOM
TOP
RUDDER
LEFT FUSELAGE SIDE
SIZE ALL SERVO SLOTS TO SUIT YOUR BRAND
DORSAL FIN
RIGHT FUSELAGE SIDE
SKY SHARK PLATE 1 3/16 FOAM BOARD


LINE OF FUSELAGE SIDES
CUTS ON BOTTOM SIDE ALL ACROSS
AT 45 DEGREES ON BOTTOM SIDE ONLY
SLOT
SLOT
PLYWOOD RIB BELOW
PLYWOOD SERVO PLATE BELOW
VERTICAL WING BELOW
PLYWOOD RIB BELOW
HOLE FOR SERVO
UPPER WING
AILERON
DO NOT CUT AILERON UNTIL LATER
CUTS ON BOTTOM SIDE ALL ACROSS
AT 45 DEGREES ON BOTTOM SIDE ONLY
SLOT
PARTIAL RIB ON BOTTOM
SLOT
FUSELAGE SIDE
TOP AND BOTTOM RIBS
RIB ON TOP AND BOTTOM
VERTICAL WING
TRIM OFF EXCESS AFTER INSTALLING BOTTOM RIB
LOWER WING
ELEVATOR
1/4 IN DOWEL
DO NOT CUT ELEVATOR UNTIL LATER
STABILIZER
SKY SHARK PLATE 2 3/16 FOAM BOARD


FIREWALL
SUPPORT, 2 REQ'D.
MOTOR MOUNT
LG SUPPORT
2 REQUIRED
1/4
1/8
ALL PARTS THIS SHEET 1/4 PLYWOOD
7/16 DRILL
NOSE SIDE DOUBLER, 2 REQUIRED
OPTICAL SENSOR
MOUNTING PLATE
TOP RIB LOWER WING, ROOT AND TIP, 4 REQUIRED
1/8
1/4
1/8
PARTIAL RIB LOWER WING, 2 REQUIRED
INSTALL WITH LANDING GEAR WIRE
WEAKEN TO REMOVE LATER
BOTTOM RIB LOWER WING, ROOT, 2 REQUIRED
SERVO REINFORCEMENT PLATES
AND HORN DOUBLER PLATES
WEAKEN TO REMOVE LATER
BOTTOM RIB LOWER WING, TIP, 2 REQUIRED
WEAKEN TO REMOVE LATER
BOTTOM RIB TOP WING, ROOT, 2 REQUIRED
WHEN GLUING RIB IN DO NOT
GLUE TO AILERON
WEAKEN TO REMOVE LATER
BOTTOM RIB TOP WING, MIDSPAN, 2 REQUIRED
ALL PARTS THIS SHEET 1/8 PLYWOOD (LITEPLY OK)


BEND ONE DOWN
45 DEGREES
BEND ONE UP
45 DEGREES
LANDING GEAR WIRE
1/8 THICK MUSIC WIRE
AFTER INSTALLING FORMERS TRIM TOP
AND BOTTOM TO FIT TO WINGS
TOP
FRONT FORMER
TOP
REAR FORMER
SKY SHARK PLATE 3 3/16 FOAM BOARD

Continued from page 31

wing curvature, and adhere the tape to the underside (top of wing). Do the same at each tape location. You should have a good approximation of the curve of the wing airfoil at this time.

Lay a bed of glue for each bottom rib. Push the ribs into the proper notches. Stretch a rubber band from the leading-edge notch on the plywood around the top surface of the wing to the trailing-edge notch.

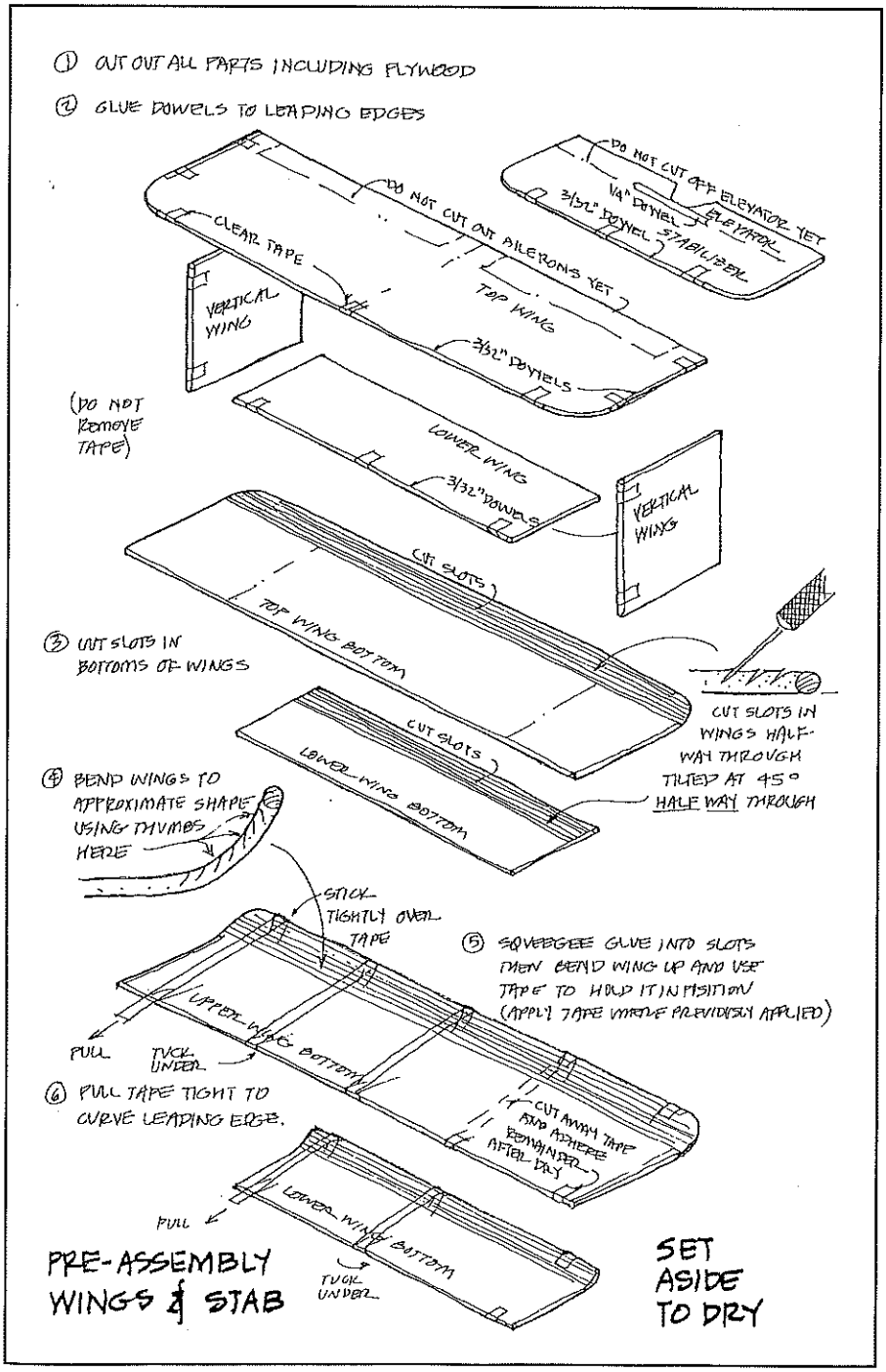
Adjust the position of the ribs accurately in location and verticality. Make sure that the leading-edge dowel is in good contact with the plywood rib. Install the four top rib plywood parts on the lower wing. Do not install the landing-gear partial ribs at this time.

Glue the elevator joiner in place.

Install blind nuts for the nose-wheel bracket. Do not hesitate to offset the bracket to one side, to make it possible to run the pushrod externally.

Slip the engine-mount assembly into the fuselage, the firewall into its slot, and glue liberally. Use a few rubber bands around the fuselage nose to pull the sides in tight.

When the wing-rib installation has dried thoroughly, cut the tape away from the underside wing surfaces, leaving behind any tape that is adhered to the paper surfaces. Cut the ailerons from the upper wing panel and cut the elevators free. Trim the tips of the lower wings to the plywood plates, letting the lower wing leading-edge dowels extend for now.



Mount the nose-wheel bracket to the firewall. While the model is top side-down, install the bottom foam board nose cover plates and the rear fuselage cover plate.

Test-fit the bottom wing into the fuselage. Trim fuselage as required for a snug fit. Drop the lower wing into position and glue into place, checking that it is at right angles to the fuselage.

Mount the top wing similarly, checking for good alignment with the lower wing.

Install the horizontal stabilizer into the fuselage, noting that it slips up into its slot far enough to allow a ¼-inch slot at the rear for the elevator joiner to work in freely.

Check alignment carefully from above and from the rear with respect to the wings.

Install the top rear plate on the fuselage, the dorsal fin, and the top front former. Use clear tape as required, but leave it in place to keep from tearing paper.

Install the remaining nose pieces, which have all been shown three inches wide (the width of the fuselage).

You may surface-mount these parts or cut them to fill in between the sides. Another way is to undercut the bottom surfaces so the parts inlay and mate, giving you a paper finish side to side.

Test-fit the vertical wings on both ends, being sure that there is equal spacing between the wings at the tips. Cut a slot for the lower leading-edge dowel to protrude through the vertical wings right behind the vertical-wing leading-edge dowel.

Glue vertical wings in place, checking for good alignment top and bottom. Use clothespins or other clamps front and back and top and bottom, to hold accurate alignment while the glue dries. This "joined-wing" arrangement is very strong.

However, it is recommended to add 3/16-inch struts from the lower fuselage-wing juncture to the top vertical wing juncture. These struts will help in two ways: the foam board will sag in time in a humid environment without the struts and the struts help distribute landing loads.

Bend up true torsion bar main landing-gear wires from ⅛ music wire. Install the formed wire in the lower wingtip plates.

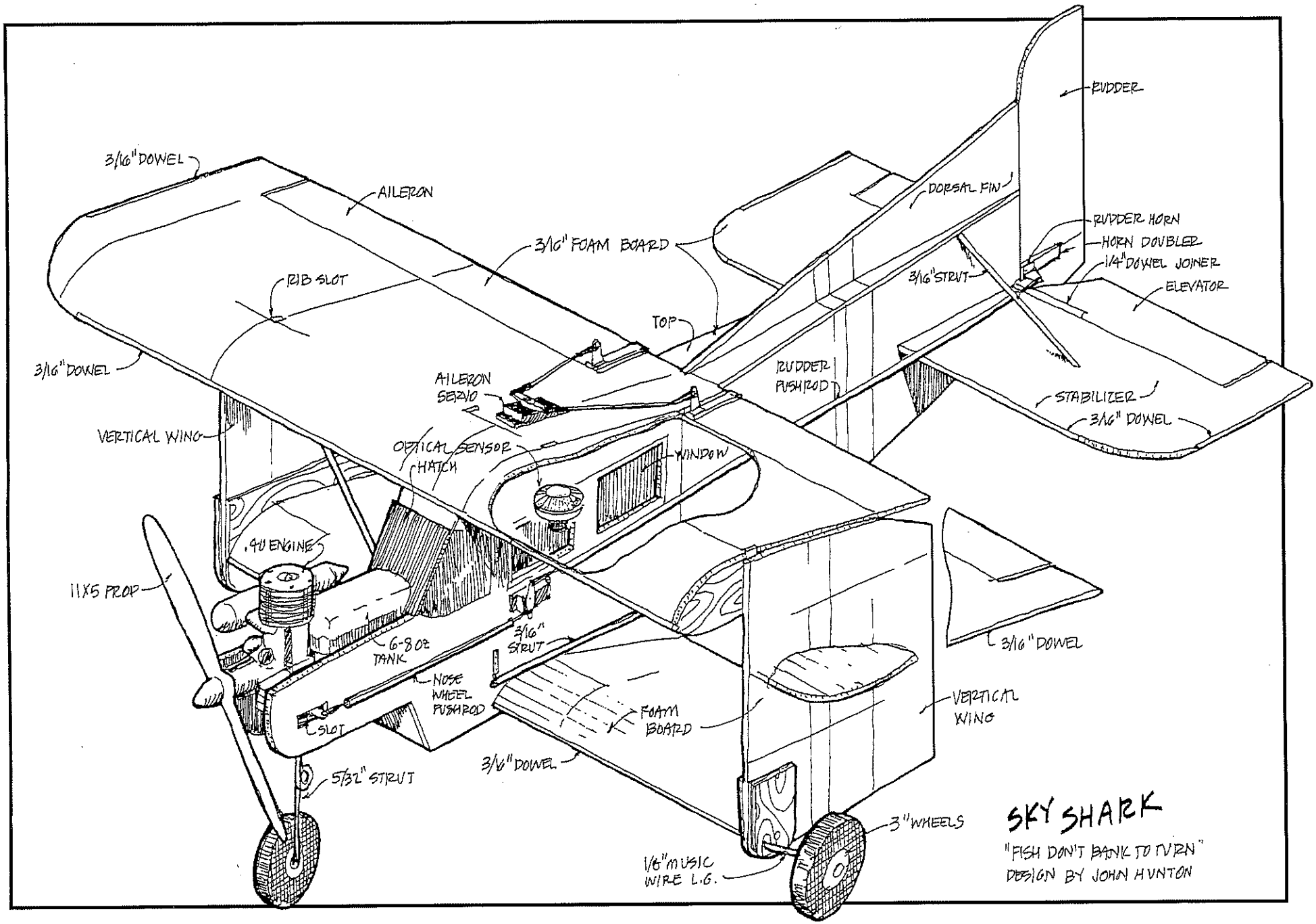
Slip the ⅛-inch-thick partial rib onto the inner part of the wire and the ¼-inch-thick landing-gear plate on the outer part. Glue the rib and plate firmly in place, and set aside to dry.

After the glue has cured, slip the ¼-inch spacer dowels into the landing-gear brackets and the partial rib, and glue.

Round the front of the bottom tip plates and the leading edge of the top tip plates. Cut off the bottom of the lower wing ribs at the fuselage. Glue on the 3/16-inch-diameter elevator braces, using them to true up the surface and make it parallel with the wings.

Install the plywood horn doublers. If you are using a transparent finish, use a felt-tipped pen to color any raw edges of foam, if desired. The airframe is ready for the paint of your choice at this point.

When using colored foam board, we used Wal-Mart™ 's color-place clear spray.


3/16" DOWEL
AILERON
3/16" FOAM BOARD
RIB SLOT
TOP
3/16" DOWEL
AILERON SERVO
VERTICAL WING
OPTICAL SENSOR HATCH
WINDOW
.40 ENGINE
11X5 PROP
6-8 OZ TANK
3/16" STRUT
NOSE WHEEL PUSHROD
SLOT
5/32" STRUT
3/16" DOWEL
FOAM BOARD
VERTICAL WING
3" WHEELS
1/16" MUSIC WIRE L.G.
RUDDER
DORSAL FIN
RUDDER HORN
HORN DOUBLER
1/4" DOWEL JOINER
3/16" STRUT
ELEVATOR
RUDDER PUSHROD
STABILIZER
3/16" DOWEL
3/16" DOWEL
SKY SHARK
"FISH DON'T BANK TO TURN"
DESIGN BY JOHN HUNTON

It is cheap and seems to be fuelproof. Coat the engine area well for good fuelproofing.

If the model is to be flown conventionally, color the bottom side of all flying surfaces dark. Place celluloid over the sensor view-window openings.

In the prototype we have learned that some momentary autopilot irregularities may come from reflections off of the vertical wings. Paint the inner vertical wing, the top of the bottom wing, and the bottom of the top wing flat black, to reduce the possibility of adverse reflections.

Install horns on all control surfaces. Install wheels using collars for positioning. Go around all edges of the airframe with a sharp, new blade and fine sandpaper, truing and smoothing rough edges. Add any trim desired.

Hinge all control surfaces. Prepare and install all control linkages.

It is very important to set all control throws properly. Ailerons and elevators should move 1/2-inch maximum from neutral up and down; the rudder should move 1 1/2 inches. Set the horns on the farthest-out hole setting.

It is rarely necessary in normal flight to exceed 1/3-stick motion left-right or up-down. The only reason for the excess motion is to overcome the autopilot if the sun is low and it gets to the sensor.

Rig the RC system so the transmitter-stick functions are left stick fore-aft: throttle; right stick fore-aft: elevator (fore is down and aft is up); right stick side to side: rudder; and left stick side-to-side: aileron.

Aileron control is not used at all for normal flight. This way the autopilot, at full sensitivity, will be overcome with roughly half-stick motion.

For a real hoot, rig aileron control to work *backward*, and use it in coordination with rudder when flying to make tighter flat turns.

The basic model assembly is complete and ready for engine, fuel tank, and RC-system installation (see diagram on plans). Observe how strong the "joined-wing" configuration is.

After RC installation, check the balance point and add any ballast necessary.

It is essential for success that the model be balanced within 1/4 inch of the location shown with the fuel tank empty. Add the countertorque weight under the right wingtip.

Flying: You will need a smooth flying surface (closely cropped grass is preferred). You will need approximately 100

feet for taking off. For landing, the longer and wider the reach, the better.

Perform a range check per RC-system instructions.

Check engine-idle setting for reliability. (It does not have to be very low with this high-drag model.)

Test-taxi at partial throttle. Make any adjustments necessary for straight-ahead tracking.

Recheck everything.

When you're ready to fly, apply full throttle to take off. If the engine sags at any time, shut it down immediately, taxi back, and reset the mixture slightly richer.

When taxiing for takeoff, apply quick jabs of steering to make corrections. Keep the elevator neutral, and the model should take off by itself if it's trimmed properly. On grass you may have to add some up-elevator to get the model into the air, then let off the up-elevator to maintain a shallow climb.

You may steer the model safely as soon as you break ground. (This is a difficult time for conventional models, where the flier tends to correct for torque effects with aileron; the conventional model will often stall and snap-roll to the left.)

Let the model climb on its own until it's 200 or 300 feet high. Turn as required to keep the model in close enough for you to see what is going on. (This is essential for a conventional model; you have to be able to see the tilt of the wings at all times.)

When you get to a safe height, throttle back and let the model stabilize in level flight at reduced power. Trim the elevator and rudder for level and straight-ahead flight.

Never let the model get downwind from you. It can get out of sight quickly.

Cruise around while you get used to the airplane. It should never be required to go wall-to-wall with the control stick. Keep your control motions minimal (⅓ motion maximum) and your turns wide.

If you run into trouble, let go of the sticks and the model will stabilize in level flight.

Well before the model runs out of fuel (after roughly eight minutes), begin to set up for your landing.

Do ovals around the field, then on a downwind run, reduce power to a safe idle to come down. Be prepared to add power at any time to go around if things are not just right.

Plan to land roughly ⅓ of the way down the field. Let the model settle onto the runway. Flaring looks good, but is not necessary for a safe landing.

The beginner should be able to fly competently very quickly with the Sky Shark. Good luck with your model.

Let us know how it goes, and let us know if you have any comments or recommendations for improving the design. MA

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Materials List

Item	Brand/size	Quantity
Fome-Cor® boards	32 x 40 x 3/16	3
Hardwood dowels	¼ x 36	1
Hardwood dowels	3/16 x 36	3
Glue	Elmer's® 4-ounce	2
Clear tape	Scotch®, roll	1
Spray adhesive	3M™	1
Foam tape	3M™	1
Paint, high gloss	21st Century®	1
Lead weight	1-ounce	1
Epoxy glue	5-minute	1
Lite-Ply	⅛ x 12 x 24	3
Lite-Ply	¼ x 12 x 24	2
Nuts and bolts	6-32 x 1-inch	4
Blades	X-Acto ™	5
Control horns	Goldberg	3
Pushrods	Du-Bro	5
Solder links	Du-Bro	5
Music wire	⅛ K&S	1
Collars	⅛ Goldberg	1
Collars	5/32 Goldberg	2
Nose wheel	5/32 Goldberg	1
Hinges	Mylar™	14
Celluloid	8½ x 11	1
Autopilot link	Futaba PA-2	1
RC System	4 channel, 4 servos	1
Engine	.40	1
Propeller	11 x 5	1
Spinner	3-inch	1
Lite wheels	3½-inch	3
Fuel tank	6-ounce Sullivan	1
Fuel tubing	Goldberg	1