SQUARE TRAINER

An R/C Project For Beginners

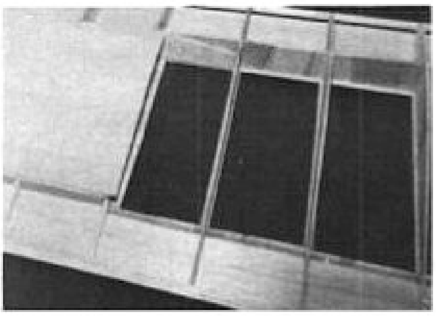
By GEORGE WILSON . . .Here's a scratchbuilt trainer for the beginning R/C pilot, one which will help get you into construction with complete, step-by-step instructions. And, it's a good flier too!

• Twenty years ago the R/C world was well-stocked with trainer aircraft that were inherently stable. These were the "left over" escapement-controlled planes that were the standard 1950/1960 radio controlled models. As proportional control took over, the experienced escapement flyers graduated to that type of control. DeBolt *Trainers, Esquires, Smog Hogs, Rudder Bugs,* etc. were easy conversions to proportional control. While not always slow flying because they depended on high wing loading for penetration into the wind, they were inherently stable, i.e., hands-off they would return to the normal level flight.

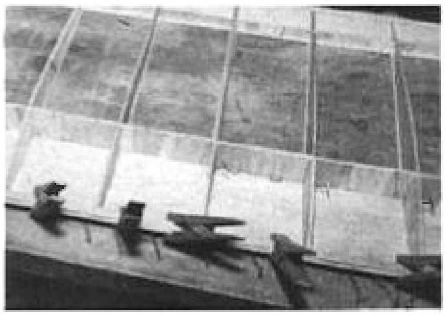
As these models flew into the sunset, the beginner was forgotten as the more experienced flyers demanded faster, more maneuverable aircraft that would defy the novice's abilities. However, many of these designs were advertised as trainers *if* one put a smaller motor in them. At that time, there were no real trainers being kitted. The writer became noisy in this respect and had a letter-to-the-editor or two published on the subject. Still nothing happened. After some correspondence with Bill Winter, the author designed the *Junior Trainer* (published in the Jan./Feb. 1973 issue of the *Junior American Modeler*). Actually, the *Mark I Trainer* was designed first but Bill thought it too fancy for the junior novice. This design was published in the March 1973 issue of *Model Airplane News*. Subsequently a number of trainer designs were published or kitted. Here again, the experienced modelers who designed these (myself included) tended to think in terms of a combined trainer/fun fly model. One goal was to produce a model that would not be "outgrown" quickly. This approach did the novice no favors in the writer's opinion but is still the approach used in many of the trainers being sold today.

A word should be said for the argument that the best trainer is a four-channel, semi-symmetrical winged bird. Those who argue for this approach point out that the slower flat-bottom winged bird can lose its utility quickly as a novice learns to fly and wants a more agile craft. To this argument we say that there are mighty few novices who can get the necessary instructor time to learn to fly using a four-channel bird. It takes a heap of learning (for most of us) to get to the point where one can completely solo this type of aircraft. If comprehensive tutoring is available, it may be possible to go this route. The slow trainer provides good building experience, forgiving flight characteristics and the reaction time necessary for a novice to pick up the feel of radio control flying. If you are talented enough to learn to fly R/C quickly and truly outgrow your slow trainer, don't despair! Your aircraft can be passed along to another beginner or used for such projects as: photo taking, glider towing, and float flying.

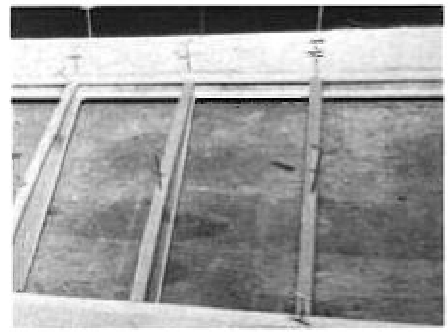
The type of aircraft we are discussing in this article is illustrated by Ramco's *First Step,* Hobby Lobby's *Telemaster,* Goldberg's *Eaglet,* Sig's *Kadet* and Kraft's *Trainerkraft* 40. These aircraft are kitted and relatively simple to build. If you can build well, try an R/C assisted Old Timer



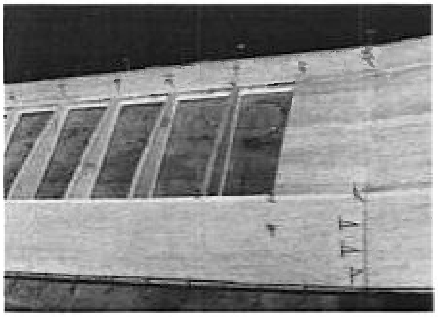
The trainer's wing is flat-bottomed, and it is easily built on your work surface. Note that the vertical-grained webbing is "remanufactured" balsa. Great use for scrap!



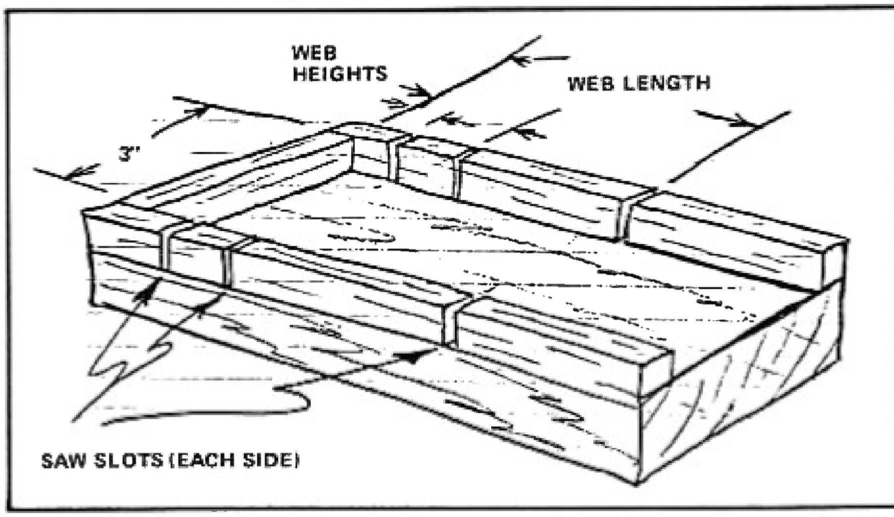
The bottom sheeting is dampened with water and rolled up under the leading edge. Titebond does the gluing job well. Clothespins(by the dozen) hold the bottom while glue dries.



Cap strips and rear top sheeting are shown in this view. Pin down surfaces to be glued until they are set to insure a good glue joint.



Top leading edge sheeting is added like that done on the bottom leading edge. Moisten the outside first and it will tend to wrap itself around the wing. Use plenty of pins!



Razor saw jig for cutting wing webs from 3-inch sheet. The base is from 3/4-inch soft wood. The saw slots are carefully cut with the razor saw after the parts are cemented together. Cut height size first. Cement into a long strip and then cut to length, using the jig.

or a model like John Laycock's *Cavelier* (May 1984 *Model Aviation*). Incidentally, most powered gliders do not make good trainers. Their flat glide and slow control reaction time makes them uncharacteristic of other powered aircraft. You will have enough trouble getting a lightly loaded powered aircraft to settle in for a landing on a warm day. . .the glider may fly on and never let you practice touch and goes.

If you are game for a real learning experience, read on. . .a scratch-built trainer may be for you.

DESIGN FEATURES

The *Square Trainer* is an inherently stable, slow flying aircraft that is easy to fly. It is not very aerobatic. The characteristics that make a good stunt aircraft are exactly what a novice doesn't need: in the hands of a novice these characteristics lead to early disasters! The model will accept a range of two-cycle engines from .30 to .45, and is ideal for a .40 four-cycle. Any radio of three or more channels will work. . .servos in the small to large sizes will work just fine.

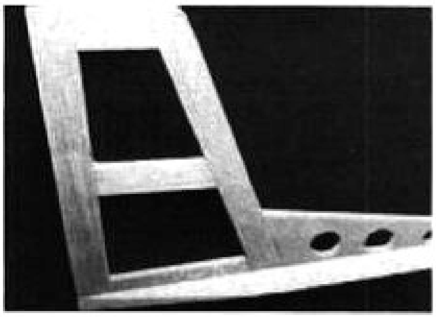
The landing gear is widestanced (main wheels wide apart) for greater stability on the ground (especially under windy conditions). The nose wheel is not steerable, but casters freely in response to air rudder steering. If you fly from a smooth field or asphalt, a straight legged, steerable type can be used. Rough fields are very hard on servos used to steer a nose wheel. Tail-dragger gear is not recommended for novices. Nose gear protects the propeller and positions the model for easy takeoffs. Note the bumper under the stabilizer to protect it from nose high take-offs and landings.

The general configuration of the Square Trainer borrows from many sources among them: Bob Machado's *First Step,* the M.E.N. *Buzzard Bombshell* and the author's early trainer designs. It has low wind loading to make it fly at slow speeds and long nose and tail moments to make it directionally stable. The wing has moderate dihedral for easy turns and the inherent capability to return quickly to straight and level flight from most any attitude.

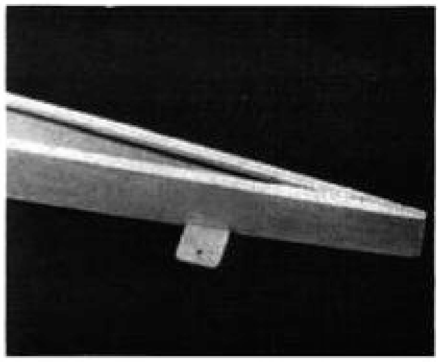
Perhaps the major design feature in the *Square Trainer* is its simple construction. Each step in the design was thought out to compromise: ease of construction, good flight characteristics and the ruggedness

MATERIAL LIST

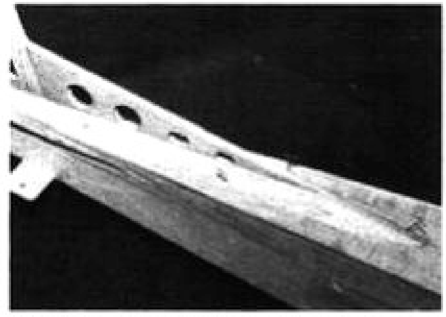
QTY	MATERIAL	USE
13	2/8x3x36 Balsa	Fuselage sides and wing ribs
6	1/4x1/4x36 Balsa	Fuselage longeron and wing L.Es
2	1/2x36 Triangular Balsa	Fuselage longerons
3	1/4x3x36 Balsa	Tail surfaces, wing tips (doubled) & F2A (tripled)
7	3/32x1/4x36 Balsa	Cap strips
7	3/32x3x36 Balsa	Wing sheeting and webbing
4	3/32x2x36 Balsa	Wing sheeting (T.E.)
8	3/32x1/4x36 Spruce	Spars
1	1/16x6x48 Ply	Fuselage doubles
2	1/8x6x48 Ply	MTR. mount, bumper (doubled), dihedral braces, stab. & gear mounts & fuse. bottom (front)
17	6-32 Blind Nuts	Gear, motor & stab mounts
10	6-32x3/4 Steel Screws	Motor & nose gear mounts
7	6-32x3/4 Nylon Screws	Main gear & stab mounts
4 ea.	(to fit) Screws & Nuts	Motor mounts
2	2 3/4 or 3 Wheels	Main Gear
1	2 1/4 Wheel	Nose Gear
1	Nose Gear	Nose Gear
1	Main Gear/Axles & Fittings	Main Gear
2	Control Horns	Rudder & elevator
7	Hinges	Rudder & elevator
1	5/16x12 Dowel	Wing hold downs
	Rods & Connectors	Throttle linkage



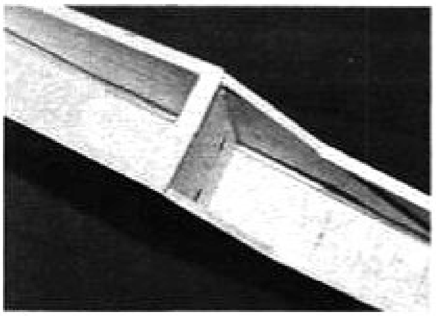
The vertical and dorsal fins are made as an assembly. Pin the assembly in place on the fuselage top and trim the rear of the fairing to match the fuselage.



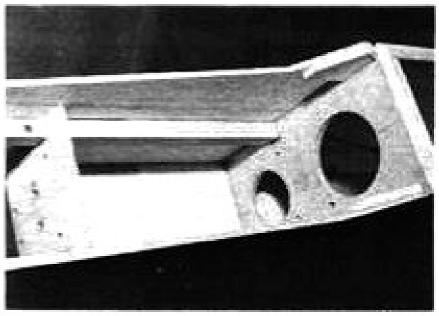
Rear of the fuselage after joining the two sides. Stabilizer mount has been installed.



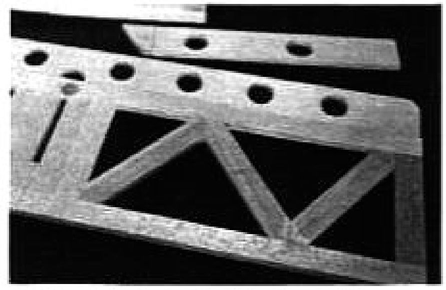
Note push rod exit and joint in side of sheeting. Nyrod or similar material makes a good push rod exit, but several commercial types are available.



View of the fuselage aft of the wing shows the inside diagonal doubler. This member is important because it adds strength to make the rear of the fuselage rigid.



Front of fuselage during construction. Cutouts for lightening are not required, but recommended. Make sure that the blind nuts get installed before assembly.



Horizontal stab and rudder from 1/4 sheet. This type of construction is relatively warp free. Note the 1/2-inch dowel insert at center-rear of stab. Two more were added later to accept the front hold down screws.

needed in a novice trainer. Typical of these decisions was the choice of a Clark-Y-type wing airfoil. A completely flat bottomed wing would have been easier to build, but the better flight characteristics of the Clark-Y won out. Otherwise, the flat tail surfaces and sheet balsa fuselage are strictly for ease of building. . . Square Trainer will probably never win a beauty contest! The original plans were reviewed by master builder Tom Nelson, who made several important suggestions based on the old engineering principal called KISS: Keep It Simple Stupid!

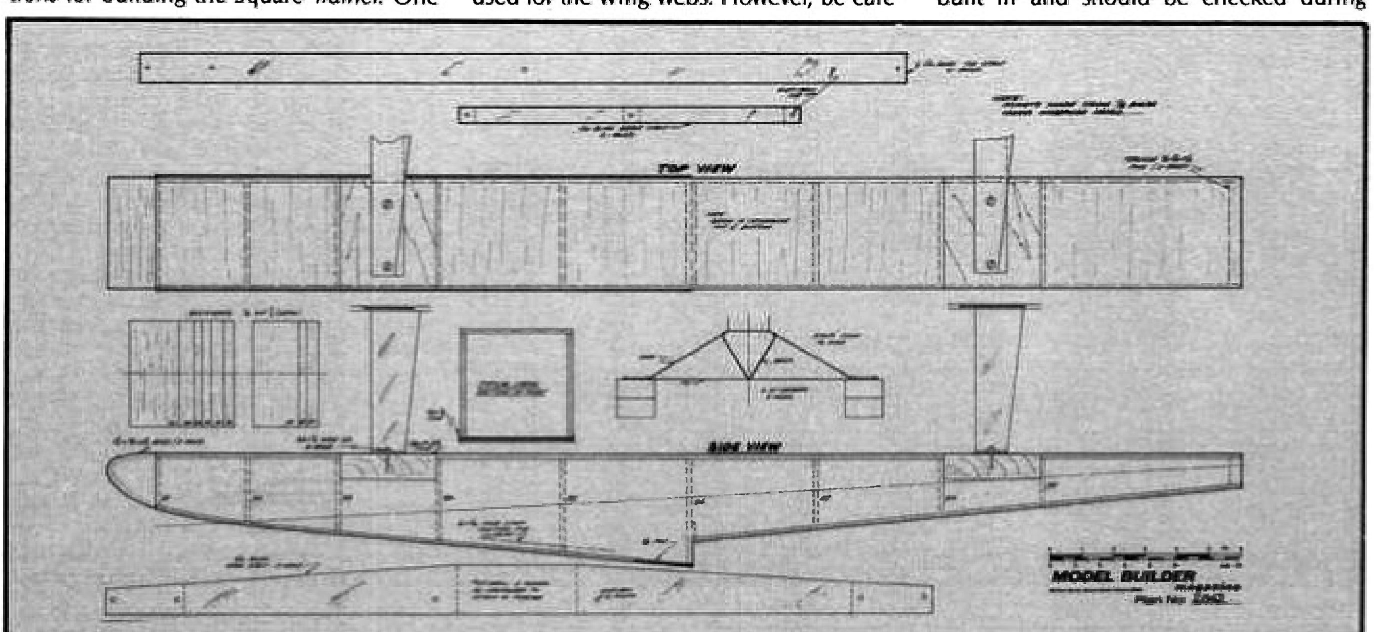
CONSTRUCTION TECHNIQUES

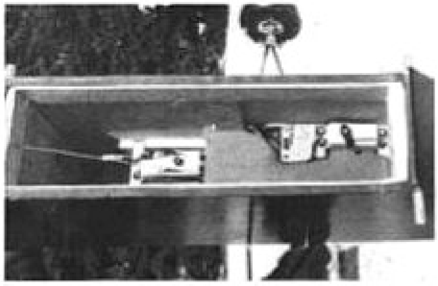
Unlike many construction articles, this one will include some detailed instructions for building the *Square Trainer.* One intent of this design was to make it simple enough for relatively inexperienced builders to construct. Kits are great for the most part. The instructions that come with beginners-type kits get better all the time as does the engineering that makes these kits easier to build. On the other hand, scratch building has much to be said for it. Typically, the choice of material is up to the builder. If you need hard wood, it can be selected. Further, if you feel competent, the design may be changed to suit yourself before you buy the materials.

On the subject of materials, do not be afraid to substitute (within reason) materials of equal or greater strength. Typically, if you have scrap balsa avilable it can be used for the wing webs. However, be careful about adding weight. Using 1/8 sheeting on the wing is not advised. The 3/32 sheeting was chosen to be compatible with the 3/32 spars and a wing rib shape that does not require notching. If your building competence is good, consider using 1/16 sheeting and notching the spars into the ribs. In fact, 1/4 x 1/8 spar material is readily available and stronger than 1/4 x 3/32. Thinner sheeting will most probably have adequate strength and will result in a lighter model.

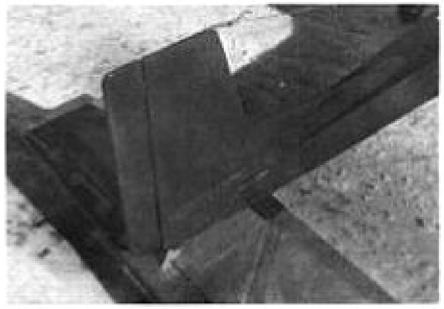
On the other hand, whether you are scratch building or kit building, certain basic things *must not change:*

1. The incidence of the wing and horizontal stabilizer must be carefully built in and should be checked during





Ample room exists for the installation of any radio. Black item to the right of fuselage is the gloved hand of the photographer's assistant. Winter in New England!



Finished but before trimming view of the tail. The rudder push rod exits on the left side similar to the horizontal stab rod shown.

The motor is fully exposed for ease of assembly and maintenance. Note the plastic tank hold-down mounted on a block glued to the fuselage side. Eight oz. tank is overkill for a 40 four-stroke but it fits neatly.

and after building.

2. The balance should be as shown on the plan. In a model of this size plus or minus 1/4 inch is okay. A more forward balance point will produce a more stable model. Avoid the more aft balance condition (tail heavy) unless you enjoy adrenalin fits! Better you be one inch forward rather than 1/2 inch to the rear!

3. All of the flying surfaces must be warp free. The exception here is washout in the wings. . . in this case it is intentional and must be the same on each wing.

4. Do not neglect the right thrust in the motor mounts. This will help counteract the propeller's torque which tends to run the model to the left.

Most test pilots will refuse to fly your model if 1 through 3 above do not check out. They will shake their heads about non-compliance with 4, but most probably will fly the model and then tell you to go home and put right thrust in. The balance and the warp-free surfaces are the most important. Slight incidence and thrust errors can be trimmed out with the radio during initial flights and corrected later.

If you have (or a friend has) a bench saw and a bandsaw (a jigsaw will do in most cases) scratch building becomes much simpler. These tools eliminate a lot of tedious work such as cutting out individual wing ribs. With a bandsaw 1) the rib blanks are cut from stacked sheets; 2) the rib blanks are stacked up (I prefer to tack glue the layers together); 3) the rib outline is drawn on the top of the stack; 4) the stack is sawed in accord with the outline; and 5) the stack is sanded before the individual ribs are separated from it. If you are going to cut the ribs separately, make a pattern of thin metal or plywood and pin it to the wood (make two holes in the pattern) while you cut around it with a sharp model knife. On that subject: perhaps the most important adjunct to your model tools is a fine sharpening stone. Use it frequently and you will get clean easy cuts. Many new blades can stand a touch-up before they are used!

A complete article (book?) could easily be written on model tools. However, the most important tools are a sharp razor knife (mentioned above) and sandpaper. To assure smooth and even surfaces (fuselage sides, stabilizer, wing structure, etc.) it is best to cement (use white glue or similar) medium grade construction paper to a piece of flat 3/4-inch pine board. The board should be cut to accommodate one half a sheet of sandpaper cut lengthwise. Coat the board evenly with glue. The paper will stick to it readily. Weight it down and let it dry for half an hour or so before using it. Smaller sanding blocks should also be made (or bought) using medium paper for roughing and fine (100 grit) for finishing. Avoid using unmounted sandpaper. However, it may be used to finish rounding edges such as those on the wing tips.

Another essential tool is a razor saw. This will be used along with a jig to cut the wing webs and the 1/4 balsa used in many places throughout the structure.

A *true* 36-inch (or longer) straight edge will be required to true up balsa sheets before they are used. A bench or radial saw with a fine tooth blade and a long flat fence will do this job quickly and easily.

Currently most expert builders would assemble the *Square Trainer* using one of the instant cyanoacrylate cements (Hot Stuff, ZAP, etc.) for most of the structure and epoxy cement for the motor and gear mounts and plywood doublers. A more conservative approach (that used by the author) is to use aliphatic resin cement (Titebond, Sig-Bond, etc.) for essentially all of the structure. The plywood doublers can be attached with contact cement to avoid warping that may occur if you use a water based (e.g., aliphatic resin) cement. In any case, it is advisable to paint the inside of the motor area with diluted epoxy cement to minimize fuel seepage into the wood. Epoxy may be diluted with epoxy, lacquer, or dope thinner, or 90% isopropyl alcohol. All of the cements mentioned above are hot fuel proof.

TRUING UP SHEET BALSA

Most sheet balsa will be slightly curved along its long edges. These edges should be made straight (and in some cases parallel) if they are to be used in such applications as butting up against a spar or where they are to be used in long lengths and determine the incidence of a flying surface: in our case, the top and bottom of the fuselage sides are typical of this.

Use a *true* straight edge preferably made of metal to check sheet edges and to trim them if necessary. An interesting source of this sort of straight edge is your local sheet metal shop. Scrap strips of metal trimmed from sheets are generally quite straight; check them on a known flat surface to be sure. If both sides have to be true and parallel, carefully measure equal distances at each end of the sheet from the already trued side and again use the straight edge and a razor knife to trim the second side. Two sheets can be made alike by using a

Continued on page 95

The author with his Square Trainer. You'd be hard-pressed to find an easier to fly first R/C model: high wing, tricycle gear and a forgiving airfoil. Building one is a good education too.

Square Trainer *Continued from page 30*

trimmed sheet as a template for trimming the second one. Do not worry about losing 1/16 or so from each side. The height of the fuselage or width of the wing is not all that important.

The exact dimensions of the model's structure are not important. The incidence angles are important. If you choose to vary the length, width or height of most any one thing by plus or minus 10%, you most probably will not be able to detect the difference in flight characteristics. Twists and warps, however must be carefully avoided. To help avoid them the parts should fit together without pressure. This holds true when building a kit also. Some kit manufacturers do a great job with fits; others give you fits with their fits! A little sanding or truing will minimize the warping forces built into a model.

MATERIALS

The basic wood and hardware for the Square Trainer can be purchased new for less than $50.00. This does not include the motor, radio, push rods, covering and finishing materials and adhesives. If you are a builder, much of the material may come from your "scrap" collection. If you are like the author, some of it can be "remanufactured" from scrap. Typically, the webbing between the wing and the wing ribs on the original were "glued-up" scrap sheet of a couple of different thicknesses. A proper cement join is stronger than the wood it connects. . .something to remember, especially, if you scratch build. (See material list).

For obvious reasons, the radio and motor must be your choice. A wide range of selection is possible in both cases including "pre-owned" units. If the latter are used, make sure you know the seller and have the option of returning them if they do not perform as stated by the seller.

Covering and finishing are again up to the builder. For the novice, the iron-on coverings are recommended. Use of the fabric-based iron-ons is particularly recommended for the novice. They work easily and provide additional strength. If you use a type of iron-on that may be painted: don't. it adds needless weight and makes it impossible to reheat and tighten the covering if it sags later on. The finish will be spoiled by the heat. Carefully seal the joints and ends of the covering at the front of the fuselage to help prevent fuel seepage into the wood. The instant glues do this task very well. Or, since there should be no sagging of the covering over the solid wood, a fuelproof paint may be used on the fuselage.

BUILDING THE FUSELAGE

Each side is made from three sheets of 1/8 x 3 x 36-inch balsa, trued as necessary. The front part is made from two sheets joined along one of their long sides. The rear part is made from a half sheet butt cemented (see detail, but add doublers later as instructed) to the front bottom sheet. After cementing these pieces, again check the trueness of the edges. The top and bottom should be parallel where the wing will mount. Next draw the top side outline of the fuselage on one of the glued up side blanks. Carefully pin both sides together and cut to the outline through both sides at the same time. Drill the holes for the wing hold-down rubber dowels while the sides are together. Examine the two sides; choose the best sides for outside and mark the insides (ballpoint pen or soft lead pencil) left and right respectively. Pin the two sides to your building board with the insides up and the bottoms matched together. Incidentally, an unfinished narrow flush door makes a good flat, inexpensive building board if you do not have one big enough for this size model. Mark the bulkhead locations and draw their locations (front and back) onto the sides using a square. As you add things (like doublers) these lines will be covered. Re-mark them on top of the doubling piece whenever this happens. Next, add the 1/4-square longerons at the rear top and bottom. Add the 1/8 doublers over the butt joint in the sides and over the stabilizer mount. (Use scrap wood wherever possible. The original used scrap 1/8 sheeting. . .in place of 1/4 sheet. . .in the next step. These pieces were a bit wider than called for and quite hard; they were left over from the fuselage sides.) Add the diagonal doublers behind the wing location, those beneath the wings and vertical pieces under the wing location. Use a temporary 1/4-square piece to assure a tight fit for bulkhead F3. Cut the front 1/16 plywood doublers and install them with contact cement, add the 1/2-inch triangular piece over the main gear location. Cut the bulkheads from plywood and balsa as called for on the plan. . .be very careful to make them square. Check the height of the fuselage sides at F2 and F3 (it should be the same) and adjust the height of F2 and F3 if necessary. It is best to cut the notches for the 1/2 x 3/8 hardwood motor bearers and the cut backs for the 1/16 doublers with F1 and F2 tack-glued together. For maximum strength, notches should be a snug fit for the bearers. Install the blind nuts (3 in each side) in the motor bearers. Use epoxy under the nuts and coat the inside of the holes through the bearers with epoxy. Similarly, install the blind nuts in the firewall as required for the nose gear bearing. Cement the motor bearers to the fuselage sides. This completes the two sides.

Mark the bottom center (both front and back) on the bulkheads. Cover the work surface with paper and draw a straight (center) line on it a little longer than the fuselage (about 55 inches). Draw the bulkhead locations perpendicular to this line. Cover the paper with wax paper or plastic film. Make a trial assembly of the sides and bulkheads F1, F2 and F3 over the centerline, making sure that the center marks on the bulkheads are exactly over the line and that the bulkheads are perpendicular to the sides. Adjust the fits as necessary and when everything fits, disassemble enough at a time to properly add cement and carefully reassemble. Make sure the sides are perpendicular to the board and parallel to each other. Allow this much to dry thoroughly. . .this part of the structure is the base for the alignment of the whole aircraft.

With the fuselage structure pinned to the board over the centerline, draw the rear ends of the sides together and trim the 1/4-square longerons to the proper taper. A razor knife, razor saw, and a sandpaper block will all be helpful in doing this. Make sure the rear end is directly over the centerline and perpendicular to the board. From scrap 1/4-inch sheet, cut a filler to go between the sides at the rear end. . .this piece adds strength, but mostly provides some wood for anchoring the rudder hinge. If you skills are up to it, it is recommended that you mount the blind nut that holds the rear of the stabilizer inside of the fuselage rather than on the outside as shown on the plan. This will require a slot to be made in the sides just above the tapered bottom longeron to accept the nut's flange. Also, a hole has to be drilled up from the bottom (half in each side) to allow the screw to pass into the nut. In any case, use nylon screws to hold the stabilizer and do not use greater than 6-32 size screws. . .you want the screws to break if a crash occurs, not the aircraft. When satisfied with the fits at the rear end, carefully cement it together and let it dry. Add F4 and 1/4-inch sheet filler between the bottom longerons above the front stab mount.

Remove the structure from the board and add the crossgrain balsa and plywood bottom sheeting. Use hard balsa in front and in back of the stab mount. Make the stabilizer mount and install its blind nuts using epoxy cement. Carefully cement the stab mount in place.

Now is the time to install the receiver, servos, batteries and push rods. Make sure the rods are installed such that they do not bind. Otherwise, little help can be offered here because each R/C system is different. If you have never installed a system before, try to get help. It is downright amazing how often a novice's aircraft gets to the flying field with the controls working backward or binding too much to allow a safe test flight. Incidentally, any competent test pilot will refuse to fly your airplane if any of the above problems are present.

Install the crossgrain top sheeting and tank compartment floor. Make the motor mount board and fit it to the motor you plan to use. Install the triangular block behind the top of the windsheild. Note that this block can be made by cementing three pieces of 1/4-inch sheet together. Install the 1/4 x 1 pieces at the top inside of F2 and F3.

The main gear should be mounted with four screws and blind nuts. Here again, do not use over 6-32 nylon screws. In this case, you want the gear to break off without breaking the fuselage. Make sure the gear is mounted perpendicular to the fuselage: use a square to mark the location. I like to drill one hole through the gear and fuselage and put a screw and nut into this hole to hold the gear while drilling a second hole. A screw and nut are then put into this hole while the remaining two holes are drilled.

This completes the fuselage except for sanding and trimming the top to fit the wing. This is done after the wing is completed. Foam tape may be installed around the wing seat to cushion the wing and keep oil and dirt out.

BUILDING THE TAIL SURFACES

These parts are made from 1/4-inch sheet and 1/4 x 1 strips. The pieces for them can be cut to length over the plan using a razor saw. Construction is also done over the plan (or a copy of it) using wax paper or plastic film to protect the plan and prevent the cement from sticking the frames to the plan. Sand the edges round as shown on the plan and sand all the joints by sweeping a large sanding block over the entire surface. The tail surfaces should be covered before the hinges are installed. Hinges are your choice. The least expensive and best working hinge is made by figure-8 stitching monofilament nylon thread between the fixed and movable parts. Whether you use this approach or one of the fine commercial hinges, it is important that the movable surfaces work very freely.

The vertical fin, dorsal fin and the 1/2-inch triangular stock fillets should be made into an assembly before they are attached to the fuselage. Do not trim the fillet pieces before assembly. They are most easily trimmed when fitted to the fuselage but before cementing. Make sure this assembly is perpendicular to your work board when it is resting on its bottom. . .this will help assure that it will be vertical with respect to the fuselage when installed.

Do not forget to install the 1/4-inch plywood bumper in the bottom of the horiontal stabilizer. The bumper will help protect the bottom of the elevator if the tail drops too far on takeoffs and landings.

Hardwood insets and washers under the screw heads will make the stabilizer mounting quite rugged. Vibration and use will tend to enlarge the screw holes if they are made directly through the balsa frame.

BUILDING THE WING

The wing may be built over the plan. However, I prefer to save the plan and to build wings and tail surfaces over a plain piece of paper that has been marked with just enough lines to tell where the spars and ribs should be located. Incidentally, unwrinkled wrapping paper is great for this application. After marking the spar and rib locations, cover it with wax paper or plastic film before you start construction. As you build a wing of this sort the plan soon gets covered by the structure. For this reason, it is best to mark rib locations in front and back of the leading and trailing edges respectively. It will be necessary to transfer some of the plan locations (typically rib locations) directly onto the wood using a ball point pen or very soft pencil. Mark on the insides of the structures only; you do not want the marks to show through the finish.

The washout under the wing tips may be built in either of two ways: first, and most recommended for novice builders, build the wing structure flat and add the washout during the process of installing iron-on covering. In this case, the washout is added while the covering is being heat shrunk. Heat shrink the bottom covering and, then pin the wing to the board with the tip blocked up and heat shrink the top covering. This should add a permanent warp; touch up each side as necesssary to equalize the washout on the opposite sides. The second method most recommended for fabric covering, is to build the washout into the structure. In this case, the bottom spars, bottom sheeting, ribs and webbing are first assembled flat on the work surface. Then the trailing edge is blocked and the top sheeting and top spars added. This will build permanent washout directly into the structure.

First cut the wing ribs from 1/8-inch medium sheet. While the ribs are stacked, mark the rear spar position on the bottom using a square. True the edges of the leading and trailing edge sheeting that butt against the spar. The front edges will be attached to the 1/4-square leading edge piece and sanded round later. The trailing edge is also best trimmed after assembly to make sure both sides are alike.

Start the assembly of the first wing panel by cementing the spars to the leading and trailing edges. Then pin these assemblies to the work surface over the plan (or your marked lines). Do not try to pin through the spruce spars. It is tough to pin through hardwood and the pin holes may weaken the spar. Install the bottom cap strips. Transfer the rib locations to the sheeting.

Cut the webbing pieces to size. This is best done using a couple of simple jigs or a combination jig as shown in the diagram herewith. First cut them to their narrow dimension (crossgrain). Note that two or more layers may be cut at one time. Then in a second jig cut them to length. Incidentally, here is a great place to use up scrap wood. Any thickness 1/16 to 1/8 is acceptable. Glue small pieces together as necessary.

Using the webbing pieces between ribs, install the ribs (except for the center one and the one next to it). Use the spar locations on the bottom of the ribs for fore and aft positioning. If the ribs begin to shift from the locations shown on the bottom sheeting, adjust the length of the webbing to compensate. . .use a sanding block or insert a shim. Exact positioning of the ribs is not important but shifts of 1/16 or more should be corrected.

Do not cement the leading bottom parts of the ribs to the bottom sheeting or install the leading edge spar at this time.

Trim the two ribs each side of center to allow the dihedral braces to fit through them. (Save the second one for the opposite panel.) The center rib can also be trimmed at this time. Cut the dihedral braces from plywood and install them in the first wing panel, being careful that their center lines are exactly over the wing centerline. Note that the foreward brace goes between the spars and the rear one goes full depth of the wing in front of the rear spars. It will be necessary to cut a 1/8-inch slot in the bottom sheeting to accept the brace. Trim the bottom sheeting and spars to the exact centerline of the wing.

Install the dihedral braces in the first panel supporting them with the sections of the trimmed center ribs. Tilt the center rib sections using the dihedral template. Install a piece of webbing in front of the tapered section of the front dihedral brace. Install the 1/4-square leading edge spar, fitting it halfway through the front section of the center rib.

Next, the front bottom sheeting will be cemented to the bottom of the ribs and the leading edge. First dampen the sheeting on the outside. This is done with the structure pinned to the board. Slide a wet cloth under the sheeting. . .most often this will cause it to curl up; this makes the dampening process easier. Apply cement; block and pin the sheeting in place. If you saved the leftover cuttings from the ribs, you will find them very useful in blocking up the sheeting. Use plenty of pins to fit the sheeting to the leading edge. . .allow no gaps if you can manage it. This completes the initial assembly of the first panel.

Repeat the above instructions (except for the dihedral braces) to build the *opposite* wing panel. Make sure it is an opposite! It wouldn't be the first time that two left or two right wing panels were built, but try to avoid it.

When the second panel is complete, fit the two panels together sliding the dihedral braces into place in the opposite panel. Do any fit adjustments needed to make the panels fit together neatly. Let the dihedral braces establish the dihedral; an error here of plus or minus 1/2-degree will not be noticed. Pin the second panel (without the braces) to the work board and then cement the first one to it. Support the first panel with a square piece of wood like a 2 x 3 or something similar. Allow this part of the structure to dry thoroughly.

Refer to the comments about washout in the beginning of this section before installing the top spars and sheeting. These are installed one panel at a time with the panel pinned to your work surface.

Cement the top spars to the top sheeting and install these assemblies. Dampen the outside of the top front sheeting before it is installed. It should curl nicely and be easy to fit to the leading edge. Use plenty of pins. Prepare the top rear sheeting by tapering it to fit the bottom sheeting. This can be done using the large sanding block and a razor plane if you have one. Mark the inner edge of the taper on the sheet using a straight edge and ball point pen. Place the sheet inside up with the part to be tapered at the edge of the work surface. Sand lengthwise removing material between the edge and the line. A razor can be used to remove the majority of the material but the sanding block alone is very effective. Install the top rear sheeting and cap strips.

Using the tip rib as a template, cut the wing tips from 1/2-inch sheet (or doubled 1/4-inch sheet). Cement them to the wing tips. Now, using the big sanding block, smooth the wing over all to remove bumps, humps, glue lumps, etc. The tips should be faired with the top and bottom surfaces and their edges rounded.

Install the 1/8 wire rear edge protector . . .use coat hanger wire or music wire, whichever you prefer. The center sheeting should be covered with lightweight fiberglass. Lay the cloth in position and coat with Hobby Poxy Formula II diluted to flow easily. Sand, trying to feather the ends to balsa sheeting. The center section may be recoated with well-thinned Formula II (1:1 at least). The recoat will fill the fibers exposed by sanding. Resand to remove any remaining roughness and gloss.

This completes construction except for covering and trimming to please the builder. Assembly of the overall model is easily done using screws as shown on the plan and using #64 rubber bands to hold the wing in place. Use at least four on each side.

Before you ask someone to test fly for you, eyeball the model for warps and remove them with heat if necessary. Check out the controls to see that movement of the control sticks cause the rudder, elevator, and throttle to operate in the correct directions.

LEARNING TO FLY

Learning to fly is best done with an instructor standing by your side. . .preferably with a "buddy-box" in his hand to allow him to take immediate control if you get into trouble. In any case, your new trainer should, if at all possible, be checked out initially by an experienced pilot. After a checkout flight he will help you trim the aircraft so that it will fly straight and level without having to touch the controls. When properly trimmed, a good trainer should almost fly itself on a calm day. An inexperienced pilot trying to fly an improperly trimmed aircraft is disasterville! On the other hand, it has been done. There is the most chance of success if you are flying a slow aircraft that is intended to be inherently stable like the *Square Trainer.*

Here are some rules to remember as you learn to fly a three-channel trainer:

1. Learn to fly at a site approved for learning and follow all of the local rules. If you are flying at some other site, try to get experienced counsel before you fly.

2. Check out all controls before each flight.

3. Check radio range before each flying session.

4. Takeoffs and landings are always made into the wind.

5. Try not to over control. If your control surfaces are designed correctly and your clevises are set to give the proper amount of control throw, motion of the stick will be within a half-inch of center for most maneuvers. This assumes you are using a single-rate transmitter. If you are using a dual-rate transmitter, always use the slower rate for initial learning.

6. Take off with adequate power to lift off the aircraft quickly and do not throttle back until you are at least 75 feet in the air. The last thing you want to do is stall out after takeoff!

7. Initial flying should be done at about 200 feet to give you time to recover before, as John Ross says, "you are out of ideas and altitude at the same time." Always fly upwind from where you are standing. Your aircraft will drift downwind and become difficult to see and control if you are not careful.

The most difficult maneuver initially is a simple constant altitude turn. Contrary to the obvious, turns are made mostly with the elevator not with the rudder. The procedure is to use the rudder to get you into the turn (because of the dihedral in the wing the aircraft will automatically go into a bank). Then use a bit of up elevator (and little or no rudder) to hole you in the turn without losing altitude. The novice is very prone to the maneuver known as the "graveyard spiral." He uses the rudder to get into a turn and forgets to shift from rudder to elevator. This will cause the aircraft to turn *and* dive. After a spiral dive has begun and the aircraft is in a steep bank the novice inherently calls for up elevator to stop the dive. However, in a 90-degree bank the elevator acts as a rudder and the spiral dive is made more vicious until you find out why the maneuver is aptly called a "graveyard spiral!"

Rudder and elevator act as themselves only when the aircraft is flying level. This is the most difficult thing to learn. You must automatically feel like you are sitting in the aircraft. Only then will you be able to automatically get the feel of what the rudder and elevator are doing. To quote John Ross again, his flying instructor during WWII told him "When you are in trouble and don't know what to do, level the wings first." Once the wings are level the controls sort themselves out. If you are spiraling steeply to the left, apply right rudder. It will cause the aircraft to roll to the right until the wings are level. If you are still diving, put in some up elevator to get back to straight and level flight.

The next most difficult problem is learning to fly toward yourself. When doing this, the rudder control apepars to be reversed. Most of us learned to fly by "flying over the shoulder." That is to say, pointing our body direction in the same direction that the aircraft is flying. . .this way left and right are always in their natural direction. This habit should be broken as soon as possible. You soon learn how to mentally put yourself in the pilot's seat on the aircraft; this is the real solution. Once you are making fair constant altitude turns in one direction, start alternating. Make circles upwind and out in front of you, first to right and then to the left. Then do figure-eights in front of you. Flying circles and figure-eights overhead is a waste of time. You do not get the experience of alternately flying toward and away from yourself. Also, it's tough to judge altitude when flying overhead; you do not know if your turns are at constant altitude.

Another piece of sage advice comes from Sam Frey, "Don't just 'goof around' when you are practicing. Have a plan and follow it through."

Your next big milestone is landing. Once you have constant altitude turns, circles and figure-eights under control, you may want to try looping, stall turning and many other simple maneuvers. However, you have to know how to get it back on the ground consistently in one piece before you get to be considered a student pilot with solo ability. This can be done by at first shooting imaginary landings that are made 10 or 20 feet above the ground. First set up an imaginary door about 50 feet beyond the end of the runway. It should be about 50-feet square with its bottom fifteen feet off the ground. To make an acceptable landing you must fly through that door on a flight path reasonably parallel to the runway and at a reasonable approach speed. Now you have to learn another obvious thing about flying an aircraft. Altitude is best controlled by motor speed and air speed controlled by the elevator. When flying near straight and level, increasing motor speed increases the aircraft's speed and wing lift is thereby increased. This causes it to climb. Up elevator by itself will cause the nose to pitch up resulting in more drag and the aircraft will slow down. Similarly, down elevator will pitch the nose down allowing gravity to take more effect and the aircraft will speed up.

Extending or decreasing the length of the glide in the final approach to a landing should be done with the throttle. Most important is extending the glide. If you are too high, go around again. Do not panic and dive into a landing. By using the throttle to extend the glide you minimize the possibility of stalling out. The latter is a common problem when trying to extend the glide with up elevator. Using less throttle will tend to make the aircraft settle down more quickly because less wing lift will be generated.

The last landing trick to learn is that last-second flair out that will result in a classical three point landing. This comes with practice. To maintain good control, the final approach should be made at a slight nose down attitude with final flair out just before touch down. Many novices try to let the aircraft float level on final and hope it settles out; it won't. You have to have good rudder, speed, and elevator control to effect a good landing.

Next question: how long does it take to learn to fly? Answer: that depends on how talented you are and how much time and energy you want to put into learning to fly. One of the most discouraging things to the 30-year-old student pilot is to see a flyer bring his 10-year-old son out to the field and have him ready to practice landings in a couple of hours! To some of us the feel comes easily; others are real slow. I have never known a good competitive flyer who hasn't spent many, many hours perfecting his skills. In most cases, it takes one New England flying season (May through October) to get most student pilots to attain competent solo status. This assumes that you fly several flights most every weekend.

CONCLUSION

With the foregoing words read and understood, the novice R/C flyer should be 1) able to pick out a good trainer, 2) build a good trainer from scratch if he has had some previous building experience and 3) learn to fly in as short a time as is practical. Remember that the pioneers in R/C designed their aircraft, built them (including much of the electronics and control devices) and then flew them without instruction. It is possible to build a *good* trainer and learn to fly with very little help.

The *Square Trainer* flew just as predicted. The initial flight was in a strong breeze (10-15 mph) but Ed McCarty (test pilot extraordinaire) gave it his approval halfway through the flight and didn't even need any trim! Subsequent flights in calmer air allowed prolonged hands-off flying with the motor throttled back. Take-off power with the 40 four-stroke is more than adequate. A note on breaking in four-stroke engines is probably in order: break them in like the manufacturer says to. It took about an hour of break-in before mine would really idle down and hand-start with ease.

My thanks to Tom Nelson who reviewed the original design and suggested changes that were incorporated. Also thanks to Ed McCarty for test flying and help with the photography.

To date, the floats have not been installed. However, based on the land plane performance, float plane operation should be good. If you plan to float fly, it is suggested that a hatch/water seal be installed in the fuselage opening under the wing.

This article should be helpful to the beginner and those who are instructing beginners. May it serve its purpose well! •