Surely this writer is not the only senior citizen who has harbored a desire to participate in R/C flying. Persons with well-greyed hair attend our club meetings quite often. A few of these older folk eventually become fair pilots, but often at the cost of many crashed airplanes.

This writer came upon the Austin R/C scene in the late summer of 1975. A kit trainer airplane was built as the vehicle with which to begin indoctrination into R/C flying. My good friend and instructor, George Parks, test flew the airplane and then began the task of trying to help me learn to fly.

I was not apprehensive about trying to fly the plane. After all, I had flown several hundred hours in full scale aircraft some 30 years ago, and had a good knowledge as to why aircraft behave as they do in the various flight regimes.

Only one thing can be said about my initial attempts to learn to fly - - - utter chaos! It was frightening to me and a hazard to all persons nearby. Knowledge of aircraft and aerodynamics proved to be useless if one does not know which way the airplane is headed.

Nothing wrong with the airplane - - - it was all with me. I just could not keep up with it. The realization soon came that I would never make it with that airplane. The smartest thing I did was to sell it before it was crashed beyond repair.

Retiring with bruised ego and shattered confidence, I thought about the problem. Being an engineer with some aircraft design experience, hope was born that an R/C airplane design could be built that would make the learning process easier. Hope led to action and, thus, the first of a now long line of slow flying trainer aircraft came into being.

Model I was a big brute, relatively lightweight with lots of wing area. She had full house control and was powered with a .80 engine.

Now, this was more like it! The sheer size and low flight speed made visual orientation somewhat easier. Large size and slow flight made all of the aircraft motions slower. As an engineer would say — the "time constants" were longer.

Model I was a delight to fly. She lasted through several dozen flights before being run into by a large tree. The designer even managed one or two nervous solo flights before her demise.

At this point, having been caught up in a flood of further design and development ideas, the wreckage of Model I was piled under the workbench and plans

BUTTERFLY II

A TRAINING AIRPLANE FOR WOULD-BE RC FLYERS WITH AGED REFLEXES AND FAINT HEARTS

By Bill Carter

were drawn for Model II.

Eighteen months time, and an additional ten development airplanes, have now followed Model I in the attempt to develop "the most docile trainer". Along the way, the various models have been flown by George Parks and also a number of other experienced R/C pilots. Their comments concerning the flight characteristics and suitability of the planes as trainer aircraft have been most helpful.

The end product of all the development to this point is Butterfly II. She differs only in detail refinement from the three airplanes which immediately preceded her. All of the last four aircraft have been powered by .15 size engines. This is ample power for a large trainer provided that the airplane is made light.

The K & B rear rotor .15 engine is a good engine choice. This engine idles well due to its exhaust restrictor design and has a very high power-to-weight ratio. On a power-to-weight ratio basis, the K & B engine is superior to the Rossi and Cox engines that have now displaced it in Quarter Midget racing.

An additional advantage of the .15 engine is that, in most places, engines of 0.15 cubic inch displacement and smaller may be flown without mufflers, thus saving additional weight.

Having arrived at what seems a quite good design for the gentle trainer aircraft, it is now possible to list the characteristics which it seems she should have:

(1) The plane should be fairly large (99.5" wing span in this case) in order that good visibility be possible, and also that pitch, roll and yaw motion rates be slow.

(2) A good balance must be struck between inherent stability and maneuverability.

(3) Cruising flight speed should be quite low which means that the wing loading must be low (7.5 oz./sq. ft. in this case). Butterfly II cruises comfortably at airspeeds below 15 mph.

(4) Requirements 1 and 3 mean that the plane must be built **light**.

(5) In addition to being light, there is the obvious requirement that the aircraft be capable of standing up to rough landings and other ill treatment. Butterfly II has had four ground loop-capsize mishaps to date resulting in only one broken propeller and a small dent in one wing tip.

(6) The airplane should be designed and built in such a way as to make repair easy following a crash. It would be folly to think that a working trainer aircraft is not going to have more than its share of such mishaps. Butterfly I once came in straight down at high speed. Fortunately, it crashed in a freshly plowed field, but even so, the impact was energetic enough to completely bury the engine and motor mount. The only major damage was to the wings which broke free from the fuselage and impacted the ground. Repair time: two evenings.

(7) A high wing configuration is desirable so as to aid visual orientation of aircraft attitude.

(8) Color combination of the covering should be chosen so as to aid visual orientation.

The requirements that the plane be large, lightweight and crash resistant might seem, at first thought, to be conflicting requirements. This need not necessarily be so. If properly designed, a lightweight airplane can be more crash resistant than a heavier airplane. The light plane flies slower and thus has far lower kinetic energy at impact. The light airplane may be designed with structure flexible enough to absorb the energy with less likelihood of failure.

Butterfly II and its immediate predecessors have suffered many crashes and, in general, have been well banged about. They have stood up to the punishment very well.

Butterfly II is not **just** a gentle trainer sedately cruising around at quarter throttle. She also has a sporting side to her nature.

At full throttle, the performance is astonishing. The rate of climb must approach 600 ft./min. Rough calculation and observation both indicate that the top speed exceeds 50 mph. She will do a very majestic slow roll across the field and gain altitude in the process.

CONSTRUCTION

Fuselage: This is a fairly simple fuselage to build, but it is important that the construction steps be done in proper sequence.

(1) After the fuselage sides and inner doublers have been cut out, glue the doublers to the inner fuselage sides. Try to obtain a good glue bond without excessive weight build-up by using too much glue. Lay down about 3/8" band of glue all around the periphery of the doubler. Use either aliphatic resin or white glue. For the remainder of the inner doubler, "spot weld" to the fuselage sides by using modest sized drops of glue on about 1" centers. Drill several 1/16" diameter holes in the doubler before laying doubler on fuselage sides. With the inner doublers carefully positioned on the fuselage sides, cyanoacrylate adhesive is run into the holes in the doublers so as to prevent the doubler from slipping when sides and doublers are pressed against a flat surface to allow the glue to cure.

(2) Next, attach the 1/4" balsa corner stock to the fuselage inner sides to form the upper and lower longerons. The

BUTTERFLY II
Designed By: Bill Carter

TYPE AIRCRAFT
Sport/Primary Trainer
WINGSPAN
99-5/16 Inches
WING CHORD
9¼" (Avg.)
TOTAL WING AREA
916 Square Inches
WING LOCATION
High Wing
AIRFOIL
Flat Bottom
WING PLANFORM
Constant Chord Center Section
Double Taper Tip Panels
DIHEDRAL, EACH TIP
2⅛" First Break
3⅜" At Tip
O.A. FUSELAGE LENGTH
42 Inches
RADIO COMPARTMENT AREA
(L) 5" X (W) 2⅞" X (H) 3¼"
STABILIZER SPAN
24½ Inches
STABILIZER CHORD (incl. elev.)
6-3/16" (Avg.)
STABILIZER AREA
151 Square Inches
STAB AIRFOIL SECTION
Flat
STABILIZER LOCATION
Top of Fuselage
VERTICAL FIN HEIGHT
9⅜ Inches
VERTICAL FIN WIDTH (incl. rudder)
5⅝" (Avg.)
REC. ENGINE SIZE
.15 Cu. In.
FUEL TANK SIZE
4 Ounces
LANDING GEAR
Conventional
REC. NO. OF CHANNELS
3
CONTROL FUNCTIONS
Rud., Elev. & Throt.
BASIC MATERIALS USED IN CONSTRUCTION

Fuselage	Balsa, Spruce & Ply
Wing	Balsa, Spruce & Ply
Empennage	Balsa & Spruce
Wt. Ready-To-Fly	50 Oz.
Wing Loading	7.5 Oz/Sq. Ft.

corner stock runs full length on the fuselage bottom but only to a 1" overlap with the rear end of the ply doubler on the top. Again, allow the glue to cure with the sides held against a flat surface. (Do not attach the forward spruce upper longerons before fuselage assembly. If this should be done, the fuselage sides would be too stiff to assemble with the fuselage frames.)

(3) The lower corner stock longerons should now be joined together with a 1/16" ply splice plate glued to the 45° surfaces.

(4) The fuselage sides are now clamped together, outside surface to outside surface, and the side outlines sanded to match. This operation leaves the rear portion of the longerons tapered as desired.

(5) Lines are now drawn on the inner surfaces of the fuselage sides for frame locations and also for the location of the fuel tank tray supports and the servo tray supports.

(6) The fuselage frames are now fabricated. The forward bulkhead is assembled with epoxy. The engine mount holes are drilled and the blind nuts (4-40) are secured in their holes with epoxy.

(7) The fuselage sides and frames are now ready to assemble. The inner doublers and corner stock longerons, which have been previously attached, add just enough stiffness to allow the sides to bend into fair curves around the frames.

(8) Since the upper fuselage is a straight line when seen in side view, it is most convenient to assemble the fuselage upside down.

(9) The RCM fuselage jig is helpful in assembling the sides and frames but is not essential. Draw vertical center lines on the forward bulkhead and the frames so that proper fuselage alignment may be achieved on assembly. The forward bulkhead is attached to the fuselage sides with epoxy. The main frame is now secured to the fuselage sides by wicking in cyanoacrylate adhesive.

(10) The frames aft of the main bulkhead may be moved forward or aft a bit from the locations given on the plan so as to give a good fair curve to the aft fuselage sides. After the aft frames are properly located, attach to sides with cyanoacrylate.

(11) The bottom of the assembled fuselage should now be sanded with sandpaper, attached to a flat block so as to trim the frame bottoms flush with the fuselage sides, and also true up any rotation of the longerons due to the curvature which has been pulled into the fuselage sides.

(12) Add the balsa corner stock stiffeners to the lower edge of the main frame and also to the rear bottom side of the forward bulkhead. These stiffeners are now also dressed flush with the longerons with a sanding block.

(13) The fuselage bottom may now be covered with 1/16" ply on the forward portion and 1/16" medium soft balsa aft. Balsa grain runs across fuselage.

(14) The fuselage is now removed from the jig (or flat assembly surface) and the spruce upper longerons are glued in place. Join the spruce longerons and the aft balsa corner stock longerons with a 1/16" ply splice plate as shown.

(15) Glue in the fuel tank tray supports, the blocks for locating the battery and the servo tray supports. The top fuselage planking and hatch may now be added.

(16) The cabin is **not** put in place until **all** components except fuselage MonoKote have been added. The tail group is covered and attached to the fuselage with 4-40 nylon screws. With all components of the finished fuselage in place (pushrods, hardware, radio, battery, padding, engine, propeller, landing gear, etc.), the fuselage Center of Gravity is located and the cabin built in place such as to put the airplace Center of Gravity right on the wing spar.

Pushrods: The two pushrods may be made from a single sheet of 3" x 36", 1/16" thick medium soft balsa. Using a long straight-edge and X-Acto knife, cut four 1/4" wide strips from sheet, keeping cut edges as near vertical as possible. The remainder of the sheet may now be cut into four strips, each about 7/16" wide. Attach two of the 7/16" wide strips to a flat work surface with a spot of glue at each end. Draw lines 1/4" apart along the middle of these strips. Bulkheads for the hollow rods are cut from a piece of 1/4" square balsa. The bulkheads are attached to the 7/16" wide strips using cyanoacrylate adhesive. The 1/4" strips may now be installed and glued in place. Cyanoacrylates are most suitable for this operation. The pushrods now have three sides assembled. Use a sanding block with fine grade sandpaper to dress off the open side of the rod so as to give a good fit for the closing side. The glue spots at the ends may now be severed and fourth side may be added. If modest care is used, the hollow rods will come out quite straight. A razor plane or sanding block is used to dress off the outstanding edges. The ends of the rods are 1" long pieces of 1/4" square spruce which are sanded to be a smooth push fit into the hollow ends of the balsa portion of the rods. The spruce ends are center drilled so that the threaded metal ends may be screwed into the spruce. After the threaded metal rods are screwed into the spruce 1/2" or so, the threaded rod and the spruce are locked together by running cyanoacrylate into the other end of the drilled hole. The spruce plugs are now pushed into the hollow ends of the balsa portion of the pushrods and are secured by cyanoacrylate. The hollow balsa pushrods save quite a bit of weight over birch dowel rods and, most important, the weight saved is toward the rear end of the airplane. Construction time for a pair of these rods is less than one hour.

Tail Group: These surfaces are constructed on the plan using aliphatic resin adhesive. Note that the spars are continuous and that the ribs are interrupted. The leading edges are sanded half round and the elevator and rudder are sanded to a taper so as to be about 1/8" thick at the trailing edges.

Wing: As per Craft-Air instructions. (Note: There have been a few minor modifications on the Windrifter wing instructions as they appear in the kit.)

(1) Cut the wing views from the plans and pin down the right wing plan, under waxed paper, to your building board. Both the center section (root section) and the tip section of a wing half will be constructed simultaneously.

(2) Set the squared end of a 21" x 1/8" x 3/8" spruce spar at the line between the two touching W-4 ribs, and extend to your left beyond W-1.

(3) Butt a 30" spar to that and extend to the tip.

(4) Repeat this with the leading edges (L.E.) and trailing edges (T.E.), tapering the tip section L.E. and T.E. beforehand. Try a razor plane for tapering the L.E. A straight-edge and an X-Acto work fine on the T.E. No glue yet!

(5) Identify the W-1, W-2, W-3 and W-4 ribs. W-1 and W-2 are thinner than W-3 and W-4. W-1 has the tube hole near the top spar slot and W-2 has its hole about the center. W-3 is identical to W-4 except that W-3 has the hole.

(6) Place a 1/16" thick spacer under W-1 and W-2 to allow for the thickness of the sheeting to be added later. Cement in W-2 and W-3 — not W-1.

(7) Cement in the W-4 ribs. Before the cement has set on these ribs, cement in the webs. Take care not to glue the root of the wing to the tip.

(8) Cement in place all of the tip section ribs except W-4 (W-5 through W-15).

(9) Glue in the top spruce spars.

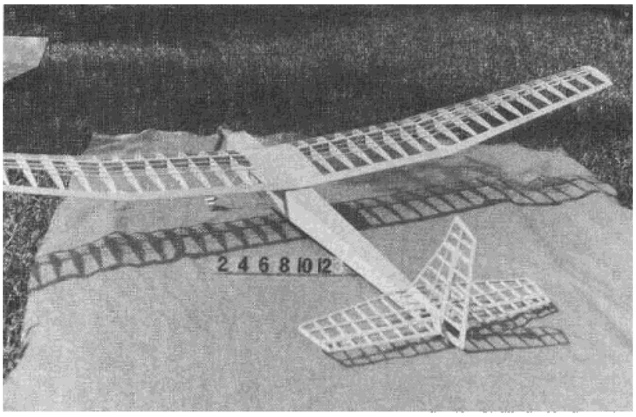
(10) Mark position, cut notches for, and cement in the 1/8" sq. spruce turbulator spars in the root section. The top of the turbulator spars should be smooth with the top of the ribs. These do not extend inward beyond W-2.

(11) Cut notches for, but do not install, the tip section turbulators until after the wings are joined.

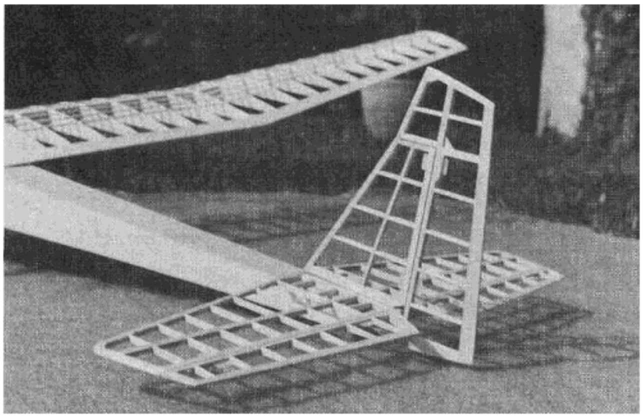
(12) Cut the inboard triangular shaped polyhedral joint braces from a 3/16" x 3/4" strip of balsa and install. Note grain direction.

(13) When dry, remove from the building board and repeat Steps 1 through 13 on the left wing. When fully dry, you should make the dihedral joints. Start with the center and then the tip joints. To make the center dihedral joint, place the 1/4" steel rod into the tubes and bring the W-1 ribs close together over a flat surface. The last W-4 rib on each wing half should be about 2⅛" above the sur-

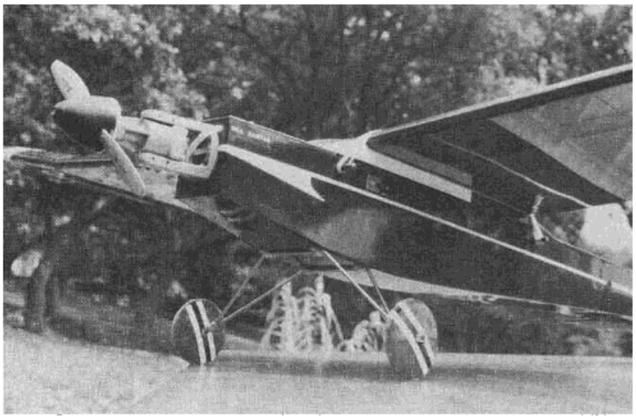
Butterfly II complete with the exception of the cabin structure. This is left to the end so as to locate wing properly with respect to the C.G.



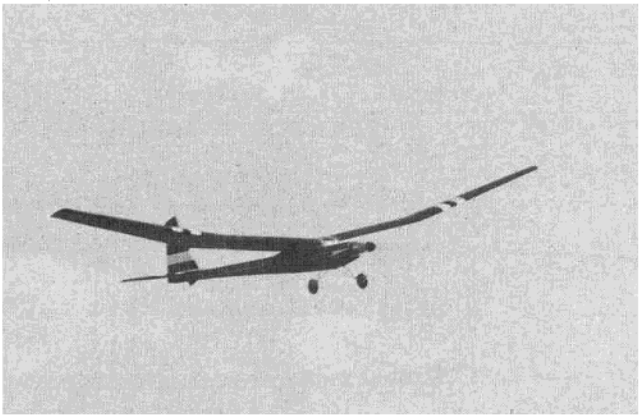
Overall view of structure. Wing is adapted from Craft-Air's Windrifter Standard Class R/C sailplane.



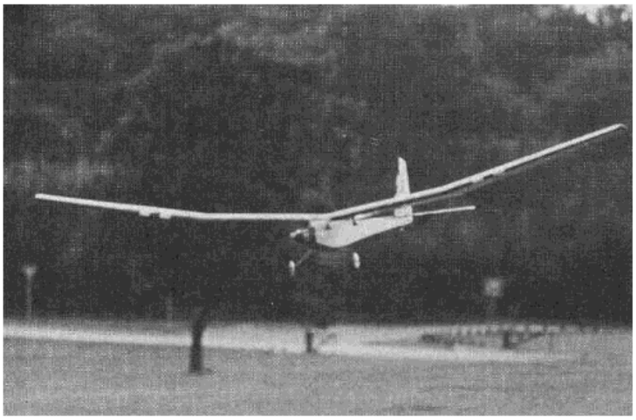
Completed tail group ready for final covering. This shows the long tail moment on the Butterfly II. Very important to keep weight as far forward as possible.



Completed aircraft showing the cabin structure added. Note the built-up balsa and ply wheels to save weight.



Cruising overhead, the airplane gives strong visual cues as to its flight attitude.



Coming in for landing.

face — 1¾" is a minimum, 2½" is a maximum. If this dimension checks, separate the two sections and machine the dihedral joint as follows.

(14) Remove the tube and the W-1 rib. Block up the outboard W-4 rib 2⅛" and position the wing section such that the L.E. and T.E. just barely overhang the edge of your work table.

(15) Holding your sanding block (80 to 150 grit) such that the sandpaper is vertical and using the table edge as a guide, move the sanding block back and forth from L.E. to T.E. and vice versa, until the T.E., L.E., and spars are vertical and square.

(16) Repeat this procedure on the other wing root section.

(17) This same procedure should be used on the tip sections, except the W-15 ribs will be blocked up 3⅜".

(18) Reinstall the W-1 ribs and the tubes.

(19) With the W-4 end ribs still blocked up 2⅛" and the steel rod in position in the tubes, bring the wing root sections together and glue in the W-1 ribs and the W-1 to W-2 spar webs. The W-1 ply ribs should be in position but not cemented at this time.

(20) Cement the tubes to the ribs and the webs with 5-minute epoxy and cap extreme ends of the tubes with balsa scraps. Don't economize on the epoxy. Puddle in large epoxy fillets around the tubes to ensure that the stress in the tubes is transferred to the spar.

(21) When this is dry, the W-1 ply ribs are to be removed to facilitate planking the W-1 to W-2 bays.

(22) Notch the ends of the 1/8" sq. pieces over the W-2 rib.

(23) Plank the bottom of the center bay with the 1/16" sheeting, grain run-

ning parallel to the spars.

(24) Install W-1A ribs. Their function is to support the top planking under the rubber bands.

(25) Plank the top of the center bay with the 1/16" sheet stock.

(26) Sand the ends at W-1 smooth and attach W-1 ply with contact cement or epoxy — not a water base glue. Water base glues warp balsa whan large areas are glued, therefore contact cement or epoxy is always preferred.

(27) Notch the T.E. at W-1 and W-2, and rim with 3/32" ply. Epoxy these ply pieces in place as they will prevent the rubber bands from cutting into the T.E.

(28) Using a similar procedure, the root to tip section polyhedral joints are made. I prefer epoxy on all joints in this area. When dry, add the two remaining spar webs.

(29) Using the edge of a flat file, roughen the dihedral brace wires to ensure a good bond.

(30) Make holes in the W-4 ribs, bend the wires, and install such that they are flush against the spars as shown. Attach the wires with a generous amount of 5-minute epoxy.

(31) Make and install the triangular shaped joint braces.

(32) Drill a 3/32" hole 1/2" deep in the right wing T.E. at W-1 for the guide pin. Drill hole perpendicular to W-1 ply, not parallel to the T.E.

(33) Sharpen one end of the 3/32" wire and push it, dull end first, into the hole.

(34) Assemble the wing halves, marking the guide pin location on the left W-1 ply.

(35) Drill the left side hole 7/64" diameter. Dull the pin.

(36) Plane the L.E. and sand your wing. It is wise to make an L.E. template from scrap cardboard using the wing section view on the plans. This is helpful in obtaining a true L.E. profile.

(37) Drill 1/16" diameter through the bottom spruce spars and install the #4 x 1/2 S.M. screws. A rubber band between the two screws will hold the wings together.

When attaching the wing to the fuselage, use four #64 rubber bands — two on each side parallel to the direction of flight. This method ensures that the wing will come off on bad landings, reducing the damage hazard, yet is sufficiently affixed so as not to come off in flight. Contest competitors may wish to risk wing damage and use more and criss-crossed rubber bands.

From RCModeler Mar.1978