PARADOX

Powered Glider For .19-.25 Engines

By dictionary definition, a glider is "a form of aircraft similar to an airplane, but without an engine." The Paradox is a glider, with the exception that it has an engine enabling it to reach the necessary altitude to glide. The last sentence is a paradoxical statement, meaning "seemingly contradictory but possibly true." Thus, my reasoning for giving this model, aircraft, glider, whatever, the name — the Paradox. The term "powered glider" is, in the English language, what is called an oxymoron, "the bringing together of incongruous contradictory ideas." The glider purist would probably consider this a better name internal combustion engine to propel it to the desired height, thus enabling the model to glide. But then I concede, "different strokes for different folks."

The basis of the Paradox design is from a 2-meter electric glider enlarged 1.33. Since it is a large model, I wanted to get the design on as little print paper as possible to save the cost of the plans. Consequently, all wing rib spacing is the same, 2-1/2". Tip panel has the leading and trailing edge of equal taper. Root panels are just reversed. Wing airfoil is a computer-generated Eppler Selig S3021094 with a slightly thicker tip to accommodate construction with approximately 1/4"

By Justin Cork

for the aircraft and the designer — so much for the name and English lesson.

Previous to this model, I built several 2-meter .049 powered gliders, oops aircraft. The results were not what I would consider satisfactory. The engines were always a problem, flying characteristics were unpredictable, etc., etc. For practical purposes, I also consider taking a long length of string with a big rubber band, or winches, to sling-shot a model a few hundred feet off the ground impractical, and electrical aircraft inefficient. It does not make sense to me to build an aircraft as light as possible and then turn around and use heavy electric motors and batteries to make the model fly. The bottom line is a large glider-designed aircraft with an

washout. An unusual feature, optional, is the inboard spoiler-ailerons. They assist in trimming and turning in conjunction with the rudder; they also pop up to act as air brakes. A very efficient flying tail is used, as there is considerable difference in trim setting under power and then glide. The fuselage is straightforward.

With a 105" wingspan, it is obviously necessary to build the wing in two sections. What was not so obvious is the best way of assembling the two wing panels to the fuselage. One day, while in a sporting goods store, I noticed a large number of Easton XX75 Cameo Hunter (XX75 Autumn Orange will also do) aluminum arrow shafts and immediately thought that they would make excellent wing joiners. One size was

not going to be strong enough so I proceeded to find out if any would fit into each other. I obtained the Easton technical bulletin from the manufacturer and this is how their numbering system works and which ones will fit inside the other. K&S brass tubing follow the same sizing.

The outside diameter code is the first two digits of the shaft size number. These digits indicate the shaft diameter to 1/64", e.g., 2213; the 22 represents 22/64", 11/32" (.34375"). The wall thickness code is the second two digits of the shaft size number. These digits indicate the shaft wall thickness to the closest one thousandth of an inch, e.g., in 2213, the 13 represents 0.013". The following shaft sizes will fit into each other with an .00525" clearance. A 2013 or 18 will fit into a 2213, the 2213 into a 2413, and then a 2413 will fit into a K&S 13/32" o.d. brass tube. Since the larger the diameter, the stronger the joiner, use the two large sizes as joiner and the brass tubing as the retainer in the wing and fuselage. The strength of the aluminum in the 96,000 psi range, straightness ±.002" (.004 T.I.R.). Aluminum, unless specially chemically treated, does not bond well to itself or anything else because the surface oxidizes as soon as it is mechanically cleaned. A way around this problem is to rub the aluminum with steel wool dipped in epoxy. The steel wool removes the oxidized coating and the epoxy protects the aluminum surface before it makes contact with the atmosphere. The non-setting rubberized-type household goo also does a good job in attaching metal tubing to balsa surfaces.

There is a sequence that should be used in building the model, the wing panels are aligned to the fuselage and the stabilizer panels to the vertical fin, both with joiners. I would start with what most builders do not like doing. Construct the full-flying stabilizers then vertical fin and the rudder, fitting the two together with music wire joiners and elevator actuating bellcrank. Next, build the inner wing panels. They must also be aligned together with the joiner and retainers in the wings. Any misalignment of these assemblies will create a big problem. The fuselage can now be built and wing and tail assemblies aligned with the fuselage.

PARADOX

Designed by:
Justin A. Cork

TYPE AIRCRAFT
Powered Glider

WINGSPAN
105 Inches

WING CHORD
11.5 Inches Ctr. Sec.
9 inches Tip Panels

TOTAL WING AREA
1086 Sq. In.

WING LOCATION
Shoulder

AIRFOIL
Selig S3021095

WING PLANFORM
Constant Center
Tapered Tip

POLYHEDRAL, EACH TIP
5-1/2 Inches

OVERALL FUSELAGE LENGTH
56 Inches

RADIO COMPARTMENT SIZE
9" (L) 2-1/2" (W) 4" (H)

STABILIZER SPAN
27-3/4 Inches

STABILIZER CHORD (inc. elev.)
5-1/2 Inches (Avg.)

STABILIZER AREA
148 Sq. In.

STAB AIRFOIL SECTION
Symmetrical (0009)

STABILIZER LOCATION
Mid-Rudder

VERTICAL FIN HEIGHT
12 Inches

VERTICAL FIN WIDTH (inc. rud.)
8 Inches (Avg.)

REC. ENGINE SIZE
.19 to .25 cu. in.

FUEL TANK SIZE
4 Oz.

LANDING GEAR
N/A

REC. NO. OF CHANNELS
4-5

CONTROL FUNCTIONS
Rud., Elev., Throt., Ail.
Spoiler-Aileron (Optional)

C.G. (from L.E.)
4 Inches

ELEVATOR THROWS
1/2" Up — 1/4" Down

AILERON THROWS
1/2" Up — 1/4" Down

RUDDER THROWS
1-1/2" Left — 1-1/2" Right

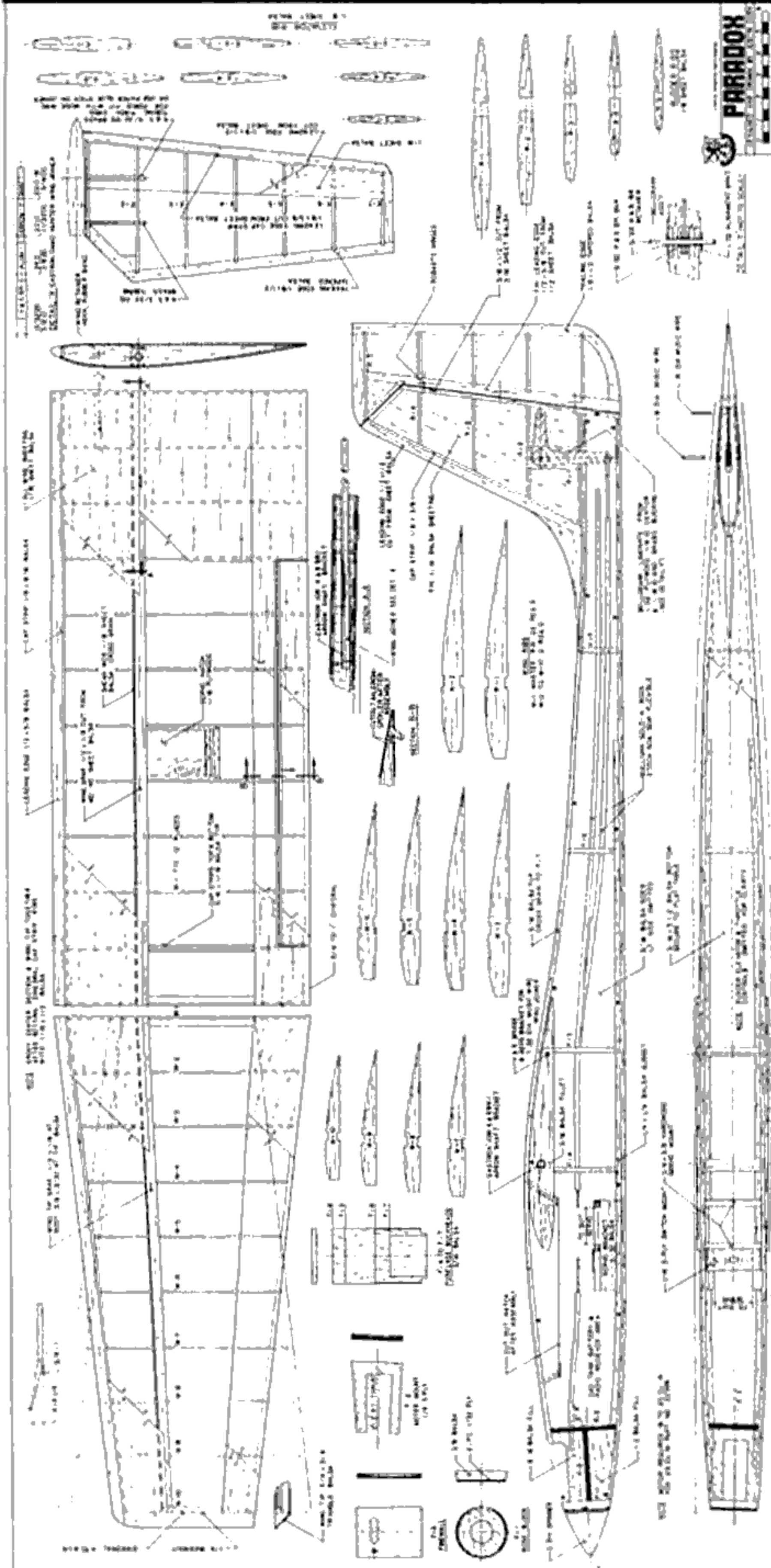
SIDETHRUST
2° to 3°

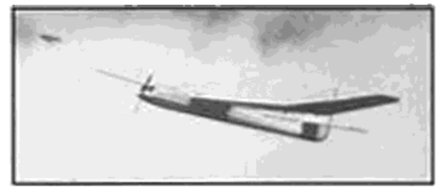
DOWNTHRUST/UPTHRUST
3°

BASIC MATERIALS USED IN CONSTRUCTION

Fuselage	Balsa, Plywood
Wing	Balsa
Empennage	Balsa
Wt. Ready To Fly	64 Oz. (5 Lbs. 4 Oz.)
Wing Loading	17 Oz./Sq. Ft.

PLAN #1265 FUII-SIZE PLANS AVAILABLE SEE PAGE 189





CONSTRUCTION

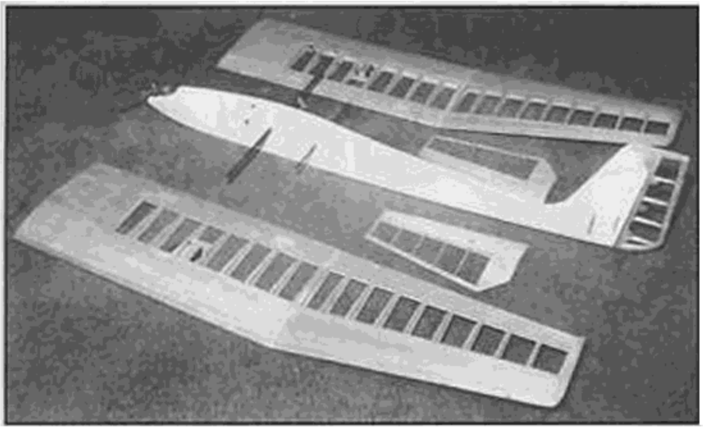
Tail Group:

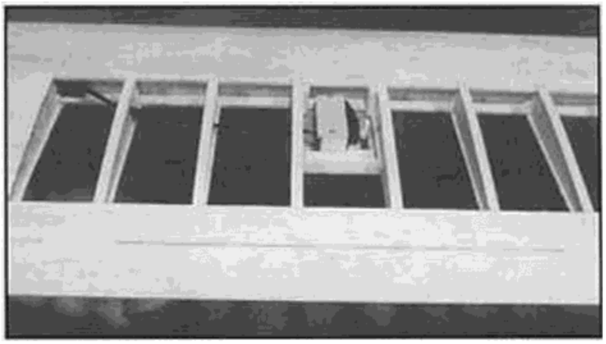
On the plans you will note I only show one of the full-flying stabilizers. Since the rib sections are symmetrical, it does not make any difference if you view the drawing as the right one from the top, or the left one from the bottom. When two are completed, you will have forgot which one was originally right or left anyway. The advantage is it saves space on the drawing and showing two would be redundant; just build two. For example, after you have cut out the ribs and checked to make sure they are all symmetrical, I doubt you will be concerned which is top or bottom, or which is for the right or left when assembling. After cutting out the ribs, notch out the 1/8" x 1/2" trailing edge from tapered balsa to retain the ribs. The leading edge cap is 1/8" x 3/8" balsa; mark the spacing of the ribs and assemble. The assembly will be very fragile; add gussets at root and tip ribs, being very careful to assure that the assembly is warp-free. Sand as required. Sheeting is now added at the rear edge to both sides before attaching to leading edge cap strip; again, make sure that no warps are induced. Add leading edge and cut and sand to shape. With a Dremel disk, taper the end and cross cut a 5/32" K&S brass tube. Bore out the first three ribs with tubing. Align elevators with 1/8" diameter music wire. Glue retainers in place with household goop (P.F.M.).

The vertical fin is assembled in the same way as the horizontal stabilizer with the exception that a stabilizer actuating bellcrank and retainers must align between the sides. The plans show what I consider the best assembly of the bellcrank to the fin; again, alignment of the complete assembly is critical. The rudder construction is straightforward. The hinges should be of the "Robart" type and the hinge pins must be aligned with the center of the circumference of the leading edge of the rudder. The complete assembly should now be ready to assemble to the fuselage.

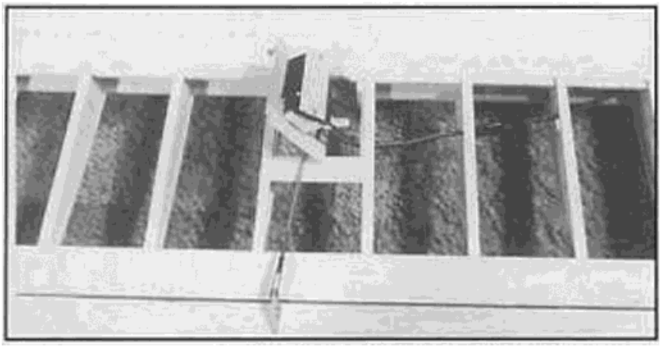
Wing Panels:

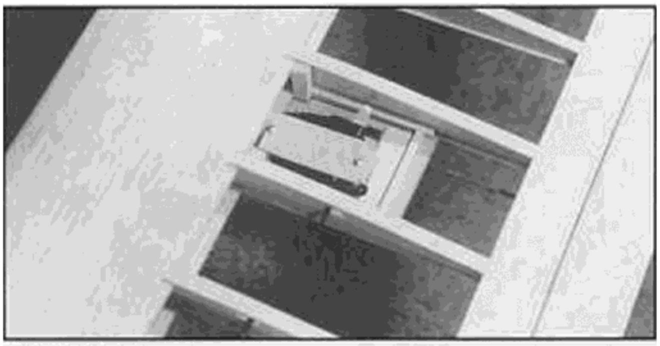
The first decision before you start to construct the inner wing panels is to decide if you are going to include what I call spoiler-ailerons. They accomplish the following functions: (a) help trim the aircraft, (b) assist the rudder in



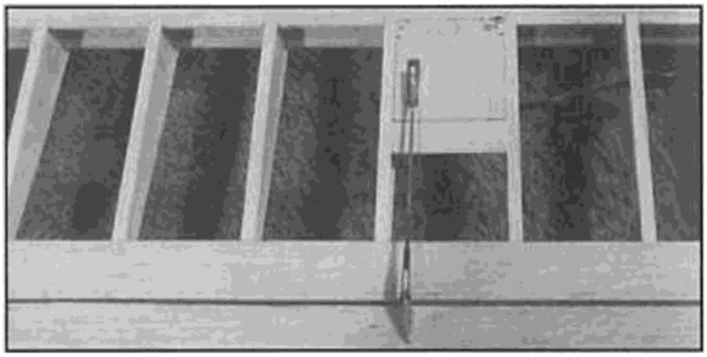


LEFT: Completed airframe; note the simple, straightforward construction throughout. ABOVE: Spoiler-aileron servo installation in wing.





LEFT and RIGHT: Simple servo mount allows easy installation and removal of servo.

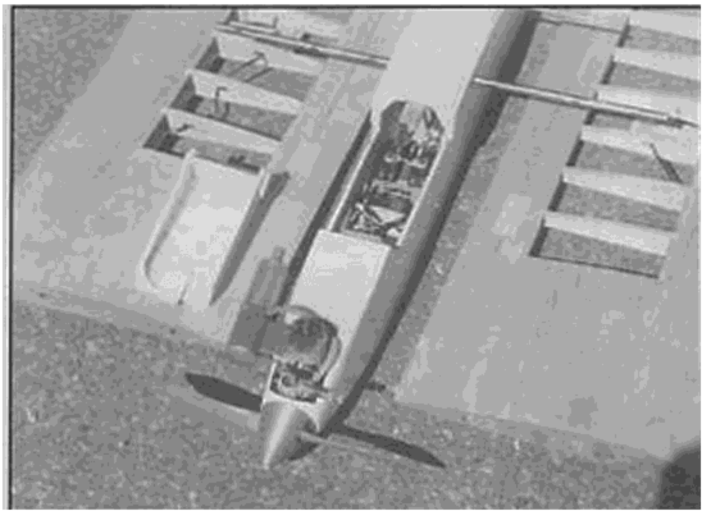


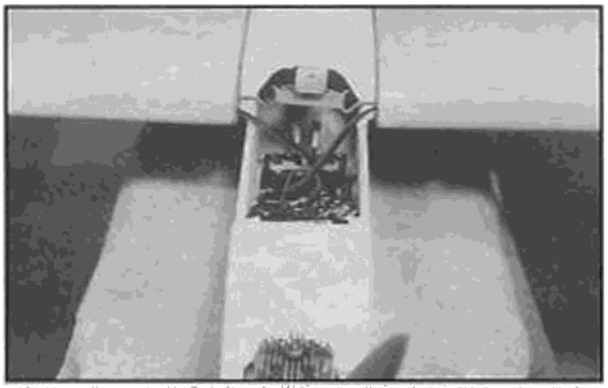
ABOVE: When screwed in place, it provides a clean flush-mount servo installation. RIGHT: Vertical fin, rudder, and horizontal stabilizer are all built-up balsa construction. Note glue stick-on fuselage. This is used on stabilizer joiner wires to help retain the stabilizers.

turns, (c) act as air brakes when they pop up with the use of the fifth channel, to lose altitude. To accomplish all these functions, you will have to have a computer radio. If you have the standard four-channel radio, just leave them out; they are not absolutely necessary. The spacing of all wing ribs is exactly the same 2-1/2", and all ribs are of the same size; consequently, it is not necessary to show a right and left panel; just make sure the spoiler-aileron cut-outs are reversed as well as the root assemblies. If this is confusing, do the right panel by turning the plans to the back side and adding light oil to see through. To be more effective, they could possibly be a little bit wider and go to the end panel. All these items are judgment calls by the builder, based on his experience and preference.

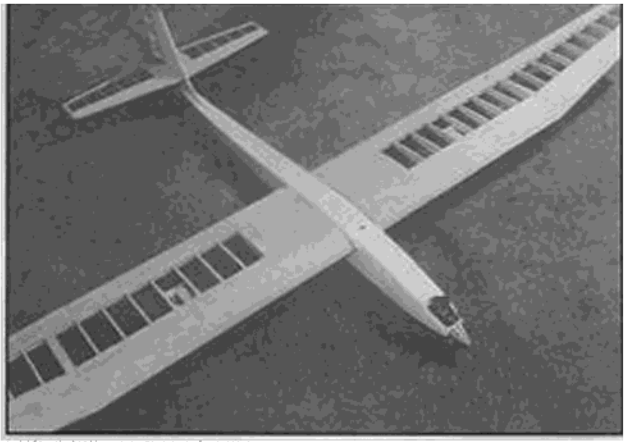
Cut out all ribs from 3/32" medium balsa. Spars, 1/8" x 1/2" wide, are cut from a sheet of 1/8" medium hard balsa, also strip-cut the leading edge cap strip. Place wax paper over the plans on a flat straight board; then, pin down the bottom spar. CA the ribs to the spar and add top spar then leading edge cap strip. Add shear webs. Now, carefully raise the assembly and place 1/16" scrap balsa under the spar. Slip 1/16" x 2-1/2" sheet balsa under the trailing edge and CA. Remove the assembly and carefully sand. Cut out holes in ribs for electrical extension to servo. Next, top and bottom sheeting is added except for root section between spar and trailing edge; joiner retainers are now added. Taper the end of a 17/32" dia. K&S brass tube and cross-cut with a Dremel disk. Bore holes in the ribs between the spars from the center of the root rib to the bottom of the spar at the fourth rib, both panels; also add the rear joiner at this time. Cut out spoiler-ailerons; add leading and trailing edges. Hatch is added with servo mounted to hatch.

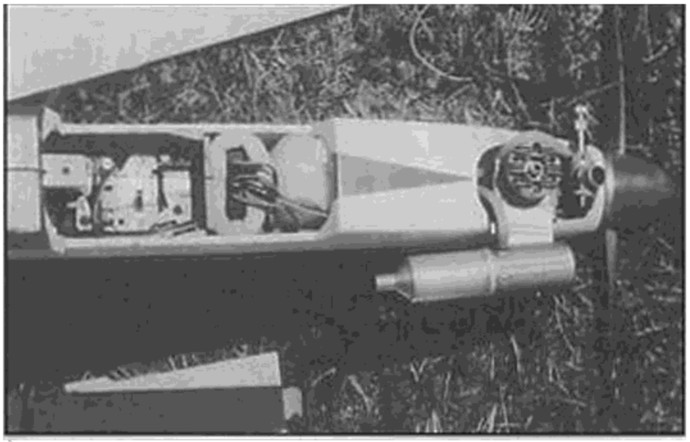
Wingtip is built the same way as root panel except approximately 1/4" washout is added. To do this, pin and weigh down leading edge. Place trailing edge sheeting under ribs. Raise trailing edge at the tip 3/8"-1/2", support in center, then glue shear webs in place to help maintain washout. After sheeting, the washout will be approximately 1/4". Do not glue root rib in place until dihedral has been sanded into sheeting. Place a 4" block under the tip rib, join tip and root panel with epoxy; then, cap strip ribs.





LEFT: Aluminum arrow shaft used as wing joiner. Ample room for all R/C equipment in fuselage. Note clean engine installation. ABOVE: Spoiler-aileron leads exit wings into radio compartment. H.D. rubber band used to keep wings in place on fuselage.





LEFT: Ready for covering, be sure to fuelproof front end and fuel tank area. RIGHT: A Fox 25 supplies the power. Radio equipment access is under hatch/canopy.

Fuselage:

Cut out fuselage sides and bulkheads from 3/16" balsa. Pin the bottom sheet to flat surface. Mark a centerline for reference. Assemble the bulkheads and then add the sides. The base acts as a reference line for the wing, stabilizer, and engine down thrust. The blue, stiff Sullivan NyRods are used to actuate the rudder and elevator. It is best that they be mounted side by side down the center of the fuselage. This will give better alignment with controls, while allowing easier access and adjustments. This will require building your own servo mounts in order to give adequate spacing between the elevator and rudder servo. Make sure there is no flexing of the inner NyRod by inserting the rod end of a 2-56 threaded rod into the inner NyRod. Now, add the rudder fin assembly.

The retainers for the wing joiners are now aligned with wing panels. It is best to box them in and use shoe-type goo to hold the retainers. The top decking can now be added and the fuselage sanded to shape. I would fiberglass the fuselage regardless of how you are going to finish the model, as it does take a lot of abuse. I am not going into how one might finish the aircraft, as it is a matter of personal preference.

Author with his Paradox.

Set-Up And Flying:

Properly setting up the model is where you will have successful flights or quickly end up with scrap balsa. The flying tail, elevators are sensitive and effective, just as they are intended to be. The aircraft has two distinct flight modes: first, when under power and climbing, and then when engine is shut down and it is gliding. This requires two very distinct trim settings. With the elevator trim set forward at the 2/3 position on the transmitter, adjust the pushrod until elevator is in the zero/zero position with the bottom of the wing. This is the setting when the model is hand-launched. There should be approximately 3/8"-1/2" up, and 1/4" down movement of the elevators. After the model has climbed to the desired height, slowly retard the throttle and it will start to descend. Now, pull back on the elevator trim until the model starts to stall. The rudder is the primary turn function and should be located on the aileron stick. The rudder throws are approximately 1-1/2" right and left. A switch on the transmitter can be used to couple this control with the spoiler-ailerons, causing them to go up to 1/2" and down 1/4" in a turn. A slide switch can also be used to activate them as air brakes.

I used a Fox .25 cu. in. for power, but it took some adjustments and time to get it to perform the way I wanted it to, but I was successful. The standard propeller called for is a 9 x 6, but a 10 x 4 APC is about right for this model. For fuel I use 15% nitro in order to keep the engine running at idle when gliding, with some castor oil included. The throttle trim should be set to shut off the engine when desired. If the engine stops shortly after hand-launch, which can and does happen, there are likely two reasons: First, the fuel setting is too lean, enrichen the setting. Second, there is possibly a fuel draw problem due to the sudden acceleration of the aircraft. Solution: launch model with throttle setting half to three quarter open; then open the throttle after the propeller starts to unwind.

Well that's about it. Just one additional item in your field kit — a lawn chair. If not, you will probably end up with a stiff neck and tired legs at the end of the day. Half hour flights are standard not the exception, even when there are no thermals. Engine power will take the model to heights where you will be afraid that you cannot see it. Glide down with the engine at idle and then climb up and do it all over again.

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