

By Ron Baddorf

The fun of flying your own ducted fan Yak or Mig in schoolyard scale R/C for a cost of about \$100.00 is now realistic. The availability of small electric ducted fan units has finally made ducted fan scale R/C practical and affordable.

The Blue Flame Blaster just released by Hi-Line, comes as a 30W motor with a 2½" diameter injection molded fan, a stator shroud assembly and nose and tail cones. The unit is purchased fully assembled and tested. The entire fan unit weighs slightly less than 2½ ounces and has a rated output of 2 ounces static thrust. With a 4-cell 270 mAh battery pack and a Cox FailSafe Single Channel receiver/servo unit with BEC, the power plant and radio weight is just under 6 ounces. This gives us an allowance of about 4-5 ounces for the model's weight ready to fly. My completed Yak airframe weighed in as follows: fuselage 2.6 ounces, wing 1.8 ounces, stab/rudder .3 ounce, for a total of 4.7 ounces.

The Yak-15 was chosen since I have had several successful Jetex powered free flight models; plus, I like the general arrangement and location of the engine. The full-scale Yak was a product of the late 1940's and was in service during the early 1950's and was used sparingly during the early phases of the Korean War.

The scale green and gray coloring of the Yak (plus its small schoolyard scale size) makes for an attractive R/C model.

Before we start construction, review the plans — think light, buy the balsa — think light, and clear off your workbench — think light. Think Light. This model **must** be built light.

CONSTRUCTION

Fuselage:

Begin construction of the fuselage by cutting out the longitudinal keel from medium 1/16" sheet balsa. The outline of the keel is noted on the plans by a series of ▼'s. Splice as required and cut out all lightening holes as shown. Remember — Think Light. Cut out all formers from 1/16" light balsa (including their lightening holes). Laminate formers F4 and F4A. Align left side formers to keel — **do not glue in place**. Cut out both side keels from 1/16" medium sheet balsa. Insert left side keel into notch in formers F2 through F12, align to longitudinal keel and CA in place. Repeat procedure for right side formers. Cut out triangular support gussets for former F1 and CA in place. Cut out wing support side pieces, with lightening holes, from medium 1/16" balsa and CA in place. Cut out stab support triangular gussets from 1/16" medium balsa and CA in place. Install, **do not glue**, a 3/32" sheet balsa "shim" and place in stab slot between stab support gussets to maintain proper alignment. Locate the 1/16" square hard balsa stringer locations, notch formers and glue in place. Install one stringer at a time on both sides. CA in place the 1/16" x 1/8" stringers from former F9 to the rear of the fuselage. Cut and notch the 3/32" medium balsa stringers for the bottom half of formers F1 through F4. Note that both the stringers and formers are notched to provide a secure fit. Make sure that the 3/32" stringers do not protrude into the air inlet duct space and interfere with the installation of the air inlet duct. Add the 1/8" diameter wooden wing hold-down dowels on formers F4 and F9. Add the 1/16" balsa gussets around the 1/8" dowels to aid in covering later.

The air inlet duct is constructed by rolling a piece of 11" x 17" copier paper around a 2½" diameter template. I used a one foot piece of 2¼" o.d. pipe which has paper wrapped around it until a 2½" diameter is achieved. Roll and tape one layer of wax paper over the pipe to aid in removing the rolled tube. Mark the exposed paper where the end of the wrap occurs. Unroll the paper and, using a "UHU STIC" glue stick (or similar) coat the surfaces which will contact each other — **not** the surface contacting the pipe. Reroll the paper back on the pipe — glue side out — and press and smooth as you roll. Remove from pipe and insert rolled tube into formers F1-F4. Mark the air inlet duct paper tube with pencil at front of former F1 and 1/4" aft of former F4A. Remove and trim with scissors. Reinsert rolled tube and spot glue with Sig-ment glue to formers F1-F4 and the 3/32" stringers. Sheet bottom half of fuselage between formers F1-F4 with soft 1/32" sheet balsa. Gently finger rub on a coat of Sig-ment glue to sheeting between formers F1-F4 and glue on a layer of lightweight white Japanese tissue. Finger rub on one more coat of Sig-ment for additional strength. Sheet bottom half of fuselage from former F9 to rear with soft 1/32" sheet balsa. This sheeting should be cross-grained with 1/16" x 1/8" hard balsa supports added to fuselage where sheeting sections butt join each other. Cut a piece of 3/8" x 3" x 3" medium balsa and pin onto former F1 for nose piece. From inside, mark the pattern location of the air inlet duct tube where it meets the rear of the nose piece. Remove pins and cut out the hole. When "fairing" in the contour of the inlet duct on the nose piece, you **must** make the front of the inlet smooth radius curves. Follow shape shown on plans. The fuselage is now set aside and wing construction begins.

Wing:

Wing construction is started by cutting out two each of ribs W1-W8 from light 1/16" sheet balsa. Cut main spars from hard 3/32" balsa. Notice shape and taper of spars as shown on the plans. Cut wing leading edge from light 3/16" sheet balsa — again noting the shape and tapers shown on the plans. The trailing edge is cut from preshaped 1/8" x 1/2" hard balsa. Pin main spars, leading edge, and trailing edge to plans. Align ribs and notch for bottom spar. Place ribs W2-W8 over bottom spar and CA to bottom spar, leading edge, and trailing edge. **Do not glue** rib W1 in place at this time. Now trim and install the leading edge from rib W2 to rib W1. Notice a 1/16" slot is cut in leading edge for a 1/16" hard balsa gusset, **do not** leave this out as it strengthens rib W2, auxiliary spar, and leading edge. Remove pins and prop up wingtips 2½" under rib W8 for dihedral. Build center section with ribs W1 and 3/32" hard balsa bottom spar, trailing edge, and leading edge. The forward auxiliary spar is cut from hard 1/16" sheet balsa. Notch ribs and auxiliary spar and CA. Add dihedral braces and all gussets as shown. Double glue with Sig-ment. Remove from plans when dry. Locate, notch ribs and install the 1/16" x 1/8" hard balsa top spars. Sheet bottom of center section with light 1/16" sheet balsa cross-grained. The top of the center section is sheeted with 1/32" sheet balsa cross-grained. Cut wingtips from light 3/8" balsa and glue in place. Sand to tapered finish.

Vertical Fin, Rudder, Stabilizer:

The fin and rudder are constructed with a 3/32" light balsa outline, 3/32" square leading edge and vertical spars, and 1/16" x 3/32" light balsa crosspieces. Cut a Sig E-Z hinge into 1/8" wide x 1" long strips. Slice the fin/rudder spars, install hinge strip and CA in place. Cut rudder control horn from 1/32" plywood. Leave bottom hinge protruding from rudder since we will splice the fuselage rear, and CA hinge and fin spar to the fuselage rear later.

The stab is constructed with 3/32" square medium balsa leading edge, tips, and spars. The stab center piece and gussets are also medium 3/32" sheet balsa. The elevators are cut from 1/16" medium balsa. Cut out the lightening holes as shown on plans. Get a used soda or beer can and cut aluminum strips 1/8" wide x 5/8" long. Slice spars and insert aluminum hinges and bend over ends, and CA. This allows elevators to be bent and used for trim adjustments.

Final Construction:

Final construction of the Yak begins with the power pod. But, before we start, a word of caution. The fan unit must be handled very carefully! **Do not** apply excessive pressure on the shroud between the strut locations where there is no support. Distortion could occur which would cause blade rub when the unit is started. Read the instructions carefully prior to handling or running the Blue Flame Blaster.

Construction of the power pod begins by cutting out former PP1 from 3/16" medium sheet balsa and gluing to former F4A. Former PP1 becomes the wing rest for wing leading edge. Formers PP2-PP7 are cut from 3/32" medium balsa. **Important** — PP2/PP3, PP4/PP5, PP6/PP7 are laminated together and are cross-grained — this is necessary for strength. Note that there are three separate formers actually constructed. Cut the fan flange spacer from scrap 1/16" hard balsa and sand as required to match the thickness of the fan flange. Place the finished spacer piece between PP2/PP3, PP4/PP5 and trial fit fan unit. The fan unit should be able to tightly slide down into and between PP2/PP3, PP4/PP5. This allows the fan to be removable. When the trial fit is completed, CA PP2/PP3 — Spacer — PP4/PP5 together on spacer only. Cut two 3/32" x 1" medium balsa side pieces to length shown on plans and glue to PP4/PP5, PP6/PP7. Assemble upside down with side pieces on workbench. Now cut out and install the two 3/32" balsa support pieces which also go between PP4/PP5 — PP6/PP7. Make sure these support pieces do not protrude into the air exit duct.

The air exit duct is prepared in the same manner as the air inlet duct was prepared — only, now we use the fan shroud as the template. This will give us a diameter of about 2 3/4". Install the air exit duct — **do not glue in place**. Cut four pieces of 1/32" x 4" x 7" for the power pod sheet covering. Butt join two together to get pieces of 1/32" x 8" x 7" for the sheeting. Cover the power pod with one of the completed sheets. Make sure the covering extends 3/16" forward of PP2/PP3 — spacer — PP4/PP5 former to fit snugly around PP1. When dry, laminate with the second 1/32" x 8" x 7" sheet. Gently finger rub on a coat of Sig-ment glue to sheeting and glue on a layer of lightweight white Japanese tissue. Finger rub on one more coat of Sig-ment for additional strength. The power pod is now complete. Slide the air exit duct rearward, slide the fan unit into place between PP2/PP3 — spacer — PP4/PP5, slide air exit duct forward over fan shroud and the power pod is ready to go.

Covering:

Prior to covering, the model is given two coats of Sig Lite Coat clear dope. The model is then covered with Japanese tissue. I chose JCI's green for all of the top surfaces and light gray for the undersides. Please note that the grain direction of the green tissue runs widthwise while the grain on the light gray runs lengthwise. If you haven't tried JCI's tissue yet, you're in for a treat! After covering is completed, shrink with water (**no alcohol**), and brush on two finish coats of thinned Sig Lite Coat clear dope. All wing, stab, and rudder trim lines and panels were "penciled" on the tissue prior to covering with a black Sharpie pen. Sharpie pens are available from local office supply stores. The fuselage panels and lines were duplicated with 1/16" matte black Chart-Pak drafting tape applied after application of the finish coats of clear dope. The eight red stars, white star outlines, and white "72" are cut from MonoKote Trim Sheets.

Final Assembly:

When all covering is complete slide the finished stab into place and glue. Slice the fuselage at the rear for the fin/rudder bottom hinge. Fit and glue the fin/rudder into place, CA'ing the bottom rudder hinge into the fuselage and installing the pushrod into the rudder control horn.

Bend the small rubber hold-down clips from .025" music wire and epoxy into place. Clear dope a small piece of gray tissue into place over each clip.

Place the power pod in position and align and glue 3/32" square balsa "keys" to the wing bottom on each side of the power pod to keep the unit from shifting and to maintain final trim once it has been established. Paint the "keys" with matching light gray paint.

Trim the Sig canopy as required for the proper fit. I carved a dummy pilot from blue foam, painted it, and glued it in place. Decorate the canopy with green Scotch 3M Decorator Tape as shown on plans.

Cut the nose gear fairing from soft 3/8" scrap balsa and the tire from 3/16" balsa. Glue in place and paint the fairing light gray and the tire black with silver center.

Equipment Installation:

Re-read the instructions carefully prior to handling the Blue Flame Blaster. Make sure there is a small capacitor soldered across the terminals of the motor to reduce radio interference. When you order the Blue Flame from Hi-Line make sure you tell them it's for R/C and they will include the capacitor in your order. Connect receiver/servo unit to the 4-cell 270 mAh battery pack and fan unit with #18 gauge wire and quick disconnect fittings as shown on plans. At this point I made two modifications to the Cox FailSafe unit. I removed the white plastic case from around the receiver and servo, this saves about 1/2 ounce. I also disarmed the FailSafe feature as explained on the instruction sheet which comes with the radio.

The receiver is placed in the location shown on the plans — making sure the on/off and motor start switches are accessible. Add small pads of foam around the receiver for protection. The servo is mounted with servo tape to the fuselage keel at the location shown on the plans. The battery pack is also mounted with foam protection — located to achieve the balance point shown on the plans.

Flying:

Prior to flying the Yak, verify the balance point shown on the plans and check for warps. Find some tall grass and test glide the Yak — adjusting the elevator as required to get a nice smooth glide.

The first test flights should be done on a calm day and with a short charge in the battery pack. Range check the Cox FailSafe with the fan unit running and verify that the rudder movement is equal and in the correct direction. If thrust adjustments are required insert shims between PP1 and PP2/PP3 for side adjustments and under PP2/PP3 or PP7/PP8 for up-down adjustments. Gradually increase the charge until full power flights are achieved.

I am presently using two chargers for my electric flying. One is a VL Products #FC-402 charger with a VL-#SJ-5 switch. This set-up has a variable charge rate with a timer and it conveniently plugs into my car's cigarette lighter. The other one is one which Hi-Line has just released. It is a new 2-6 cell charger with a 1 amp or 2 amp charge rate with an LED which goes out when full charge is reached. It also plugs conveniently into my car's cigarette lighter. Either one is very handy and highly recommended.

Once full power flights are achieved with the Yak, the results are most gratifying and realistic. The first remark from an observer watching the Yak's first flights were, "Where's the propeller?" and when I showed him the ducted fan unit — "WOW!"

Enjoy.

About The Author

Ron Baddorf, 58, has been in the model airplane hobby for 48 years. Ron started with U-Control and the Cub .049's, etc. Went into Free Flight and then into R/C. Started R/C with the old (?) Controlaire reeds. Still continues R/C today, mostly mini-sets, scale, or semi-scale fun flying. He is also into OT and Nostalgia. Recently wrote "Rare Old Timers" column for Sam Speaks (the Society of Antique Modelers' newsletter).

Per Ron, his biggest "bang" comes from models like the Yak where you get a chance to do it all — research the subject, draw the plans, design the construction methods, build it, and test it (and then rebuild it).

When not modeling, Ron is a Sr. Project Engineer with ABB (Asea Brown Boveri), Richmond, Virginia. Job entails the assembly of gas turbines for electric utilities and co-generation plants throughout the world.

Trim and Balance:

Start with the balance point on the main spar, and then move it back a little at a time until you are comfortable with the way it flies, but do not go further than 1/2" behind the main spar. Set the ailerons on the centerline of the wing and give 3/4" travel. Set the elevator so it has 3/8" movement, any more will cause the plane to stall even at high speed. This is more noticeable as the balance point is moved back. The fire wall should have 1/8" down and 1/8" right thrust built into it. The wing to stab incidence should be 0°. With landing gear installed, set the take-off incidence at 3 1/2° to 4°. When landing, bring the plane in at a slow glide and let it settle onto its belly or landing gear, do not force a landing. After the trim flight, the plane can be easily hand launched with no assistance as it flies out straight and level after it is launched.

Performance:

The performance is outstanding, it's capable of 10' inside or outside loops back to back, it will turn around almost on its axis, and rolls at more than one revolution per second. It will do vertical Figure 8s and an inverted flat spin that is out of this world. At 1/3 throttle, the plane will do most maneuvers including outside loops back to back. The plane will also fly surprisingly slow and is really stable. If a dead stick occurs don't panic, the plane glides really well. It will not tip stall, but when stalled, the nose will drop quickly (approximately 4'). If trimmed and balanced properly, it will fly upright or inverted with little or no trim or stick change. By sealing the hinge gaps, it will increase the roll rate about 30%, and also helps overall performance.

Combating:

We use a 3" metallic party streamer 20' long attached with 5' of three pound fishing line that breaks when a hit is scored. (This set-up works.) We found that regular crepe paper will break under the stress and speed of a long combat match. It also causes too much drag on the plane, and affects its performance, where the metallic streamer has practically no drag at all. On several occasions, crepe has tangled around landing gear or wingtips and causes the plane to pitch and yaw sideways, becoming hard or impossible to control, especially at low speed when trying to land. A couple of planes have been severely damaged in this way.

Now, decide on the size of the combat box, try to keep it in close so you don't lose your depth perception. Remember, it is hard to watch your plane and one or two others, so the sound of the engine is a giveaway of your position as well as sight. A quiet plane is hard to locate. Combat styles vary so here are a couple I use. Keep your plane low and you can sometimes sucker your opponent into the ground. Make an extremely low pass at low speed so as not to be heard, and when your opponent flies over, **attack!** Avoid the loop chase as it is likely to confuse you, and when looping around each other you stand a good chance of getting cut, or worse yet, getting hit by your opponent. Remember, anyone with any plane and enough guts can fly combat. Combat is probably 60% luck and 40% skill, so if you're lucky, you're ready to combat. The most important thing is to **try to remain calm**, and have fun!

Safety:

1. Always use a throttle on your plane. (No C/L engines.)
2. Shut engine off if mid-air occurs even if your plane seems undamaged, as the structure may be damaged and fail at the wrong time. (When flying over or towards the pilots, pits, or spectators.)
3. Pay attention to what or who you combat over. Fall-out from a mid-air goes everywhere and is not always controllable.
4. At first sign of trouble or confusion, abort any attack and regain your composure, it will help save your plane.
5. Use your common sense. Most people know when they are doing something that they shouldn't.

General:

I use an O.S. 25FSR on my plane which will give the plane unlimited vertical climb. The .25 will also fly about 13 minutes wide open on the 4 oz. tank. I have had an O.S. 32F on the plane at one time, but removed it because I was not comfortable with it as it was hard to keep up with, and the .25 makes it fast enough. I have not had the chance to try it, but I feel a good .15 would give satisfactory performance.

The plane is odd looking, but it is also pleasant to look at and people always come over and ask, "Does it fly?" "How well does it fly?" "Is it hard to fly?" The answer to all these questions are answered as soon as they see it fly, and their jaw hits the ground from surprise. The plane is different to look at and watch fly, so pay attention until you get used to the shape. Anyone who is an intermediate flier can handle this plane, but I do not recommend it for beginners. The plane is a blast to fly whether you enjoy the excitement of combat or you just want to have some fun with it. Many of us don't know what that stick on the left is for (myself included), but try pulling it back about 1/2 way and you can still do just about anything with the plane that you want, and it will surprise you how well it will do it. When flying combat, I recommend that you fly it a little nose heavy. For aerobatics, move the weight back until you get the desired flight. With the weight to the rear of the balance point, the plane will slow in a hard loop or a quick nose up position and this is not desirable when in combat, but enhances flat spins and other maneuvers. □

YAK-15

Designed by:

Ron Baddorf

TYPE AIRCRAFT

Electric Ducted Fan Schoolyard Scale

WINGSPAN

37-3/8 Inches

WING CHORD

7-3/8 Inches (Avg.)

TOTAL WING AREA

276 Sq. In.

WING LOCATION

Mid

AIRFOIL

Modified Clark Y

WING PLANFORM

Double Taper

DIHEDRAL, EACH TIP

2-1/2 Inches

OVERALL FUSELAGE LENGTH

33-1/4 Inches

RADIO COMPARTMENT SIZE

(L) 1-1/4" x (W) 4-3/4" x (H) 2-1/2"

STABILIZER SPAN

16 Inches

STABILIZER CHORD (inc. elev.)

4 Inches (Avg.)

STABILIZER AREA

62 Sq. In.

STAB AIRFOIL SECTION

Flat

VERTICAL FIN HEIGHT

6-5/8"

VERTICAL FIN WIDTH

4-5/8 Inches (Avg.)

MOTOR SIZE

30 Watt/Ducted Fan

BATTERY SIZE

4 Cells, 270 mAh

LANDING GEAR

None

REC. NO. OF CHANNELS

1

CONTROL FUNCTIONS

Rudder Only

BASIC MATERIALS USED IN CONSTRUCTION

Fuselage Balsa

Wing Balsa

Empennage Balsa

Wt. Ready To Fly 10.7 Ozs.

Wing Loading 5.6 Oz./Sq. Ft.