e-Dirty Birdy Twin

The finished model is prepared for its maiden flight at Site 3 at AMA Headquarters in Muncie IN.

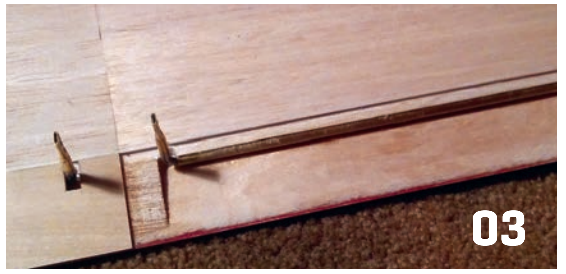
The classic model reimagined as a twin

By Dan Grotzinger
Photos by the author and Rachelle Haughn

If you had three glow-powered twin-engine models and lost two of them because an engine quit on landing approach, would you look for a more reliable power solution? The third model, a Goldberg Skylark twin, was retired before it met the same fate.

I've often thought of building an electric-powered twin. I lost my favorite airplane, a Dirty Birdy with 800 flights on it, and I wanted another.

Single-engine airplanes suffer to some degree from torque and yaw problems. It is easy to counter-rotate propellers with electric power,



01. The wing is built with spars on a work surface. The text and plans explain how to use sheet balsa as a combination TE and building jig.

02. Taping sandpaper to the bench and shaping the wing root against this surface is a precise method of joining the wing. Tape can be applied to protect some areas while sanding more from other parts.

03. This shows 1/16-inch plywood installed with the torque rod in place. The TE spar is beveled to receive the top plywood piece flushed 1/8 inch into the wing's surface. The rear edge of the plywood is beveled to mate with lower plywood, providing a 3/32-inch TE. Note the center joiner buried between layers of plywood.

canceling some of those adverse effects. With this setup, could the Dirty Birdy be even better?

I've been flying an enlarged version of the e-Cobra (*Model Aviation* 2013) with an E-flite Power 25 1,250 Kv motor, an E-flite 60-amp ESC, and a four-cell 3,700 mAh LiPo battery. With a 10 x 6 or 10 x 5 propeller, its performance is outstanding, and I am getting 9- and 10-minute flights.

These 1,250 Kv motors, designed for Pylon Racing with an 8 x 8 propeller, are perfect for the Dirty Birdy project. They don't need a large-diameter propeller, allowing the nacelles to be closer to the fuselage. The 10-inch propellers have not been a problem for these motors, and when I land, the components, including the battery, are hardly warm.

Wing Construction

I ordered a short kit from Eureka models specifically for the wing ribs and canopy. I made many modifications to the wing, but only three are necessary: installing a wiring tunnel for the power and throttle wires to the nacelles, making an oversize aileron servo mounting area that opens to the belly for cooling and allows the wires to pass by the servo, and sheeting the top of the D-tube with stronger wood to carry the load of the nacelles and motors.

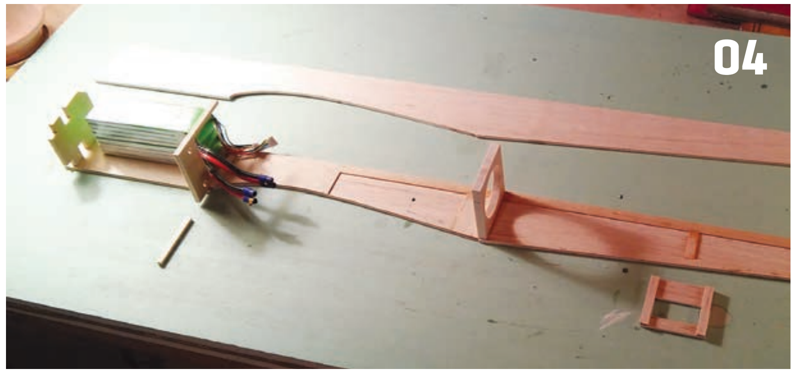
The wing root was extended 5/16 inch on each panel, and the wingtips were widened 1/8 inch at the edge near the last rib. This provides an additional 7/8 inch of wingspan to compensate for loss of area from the nacelles. The Eureka ribs are 1/16 inch short at the rear, so I used 5/16-inch trailing-edge (TE) material to maintain the wing chord.

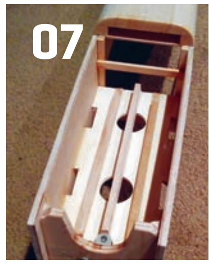
Traditional aileron torque rods from my crashed Dirty Birdy were used. I felt that two aileron servos wouldn't be beneficial. Dual servos are great for eliminating bellcranks; however, a single one weighs less. With torque rods, the wing remains clean, including no control horns.

The spars are 3/8 x 1/2 inch. Past the nacelles, you can trim the forward inside corner to a triangle shape between the ribs to save weight because this area is overbuilt. Traditional Dirty Birdy construction butts the wing halves together and joins them with fiberglass cloth.

With the motors on the wing and the airflow cutout, it would seem better to use traditional plywood joiners. I used a 3/4-inch block to join the leading edge (LE) tapered to the sweep, dihedral, and airfoil contour. It also strengthens the wing's dowels.

The bottom of the top spar and the top of the bottom spar are spliced with 1/16-inch plywood. Full-depth 1/16-inch plywood front and back dihedral braces are then applied. They will bend to the sweep. A hard balsa joiner is added to the front of the TE then the TE sheeting is joined on the inside by 1/32-inch





plywood or fiberglass cloth. The center section sheeting is joined by 3/32-inch balsa splicing recessed 3/32 inch into the rib contour.

The Dirty Birdy wing can't be built flat on the workbench because the wing does not form a flat plane line on its surface. It was intended to be built with a wing jig that uses rods installed through holes in the ribs. A solution is a modified Hal deBolt LE and TE jig system that stands a TE sheet on its edge. It is tapered from root to tip to conform to the thickness of each corresponding rib.

The bottom spar is pinned on the plans, a centerline is drawn on the TE jig, and the ribs are centered to this line and glued. This keeps the centerlines of all of the ribs parallel and eliminates twists. It is used until all sheeting is done and can be turned upside down to sheet the other surfaces.

After the wing is complete, the excess is removed to form the TE contour. The aileron torque rods are embedded between top and bottom pieces of 1/16-inch plywood inset into the TE. They are joined at the rear with enough bevel to make the final edge 3/32 inch. The insets are easily cut into the TE by pinning hard balsa strips in place to guide each cut. This is actually easier than using grooved, tapered TE blocks, which are difficult to set up and sand flush.

Fuselage Construction

All of the fuselage modifications are forward of the center of gravity (CG) except the optional use of 1/8-inch sides for weight reduction. The standard Dirty Birdy kit and the Eureka short kit use 3/16-inch sides. I used 1/8-inch wood with 1/16-inch plywood doublers in the nose back to the CG. If you do this, use 1/16 x 3/8-inch balsa strips behind the CG at the upper and lower edge of the sides for gluing surface and rigidity.

If you use 3/16-inch sides, the plywood doublers can be 1/32 inch. F1 is modified as shown, with 5/16 inch of material removed at the top and a large airflow hole cut out. The sides taper from F2 down 5/16 inch to F1 to provide a better nose profile. Large scallops should be ground out of the thin uprights of F2 that form the original fuel tank openings after the fuselage is completed. This is part of the cooling airflow.

The fuselage is framed upside down on top of the plans. The radio box (F2 to F3) should be completed first. Tack-glue cross-grained sheet across the wing saddles to hold the sides parallel and square to the formers.

The tail is pulled together over the plans and glued. All of the aft formers are added, and again, some cross-grained wood is tacked on the bottom to maintain alignment. The nose can then be glued to F1 with the battery floor/mount in place.

The sides of the battery floor/mount are curved to maintain the curve of the fuselage sides into the nose and assist in aligning the entire nose. At this point, the fuselage can be removed from the plans and the 3/8 x 1/2-inch beveled strips can be glued on top of the sides. The sheet top can be glued to the tops of the strips. When it is dry this can be carved and sanded then the scabs on the underside can be removed. I use Testors solvent glue for this type of construction because it is easy to sand.

I used a Du-Bro steerable nose gear. I cut 1/8 inch off the nylon block and positioned it upside down to place the control arm away from the battery floor/mount. These linkages can overthrow and lock. Restrictor blocks that limit the control arm's throw will prevent damage from this effect.

The battery floor/mount should have a 1/4-inch triangle reinforcement on the underside except where it obstructs the hook-and-loop battery ties. This structure will carry nearly 2 pounds of batteries at up to 8 Gs. Coat all of these joints with epoxy.

The hatch is a sheet of 3/8-inch balsa laminated

04. The radio compartment is built square then inverted on top of the plans, where the nose and tail are brought together and the bulkheads are installed.

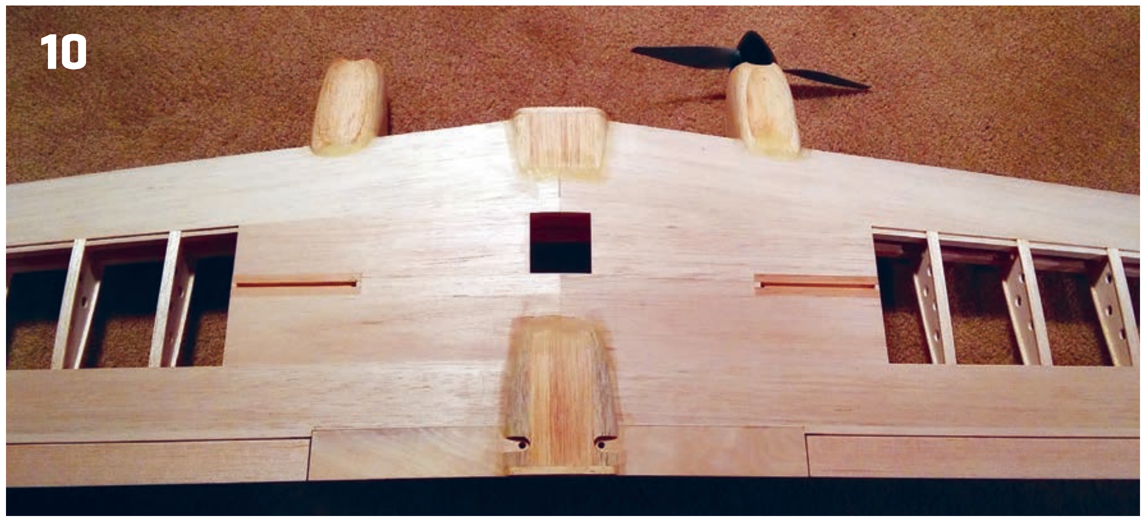
05. The nose gear must be installed before closing the belly. Note the governing block at the rear of the steering arm that prevents it from overextending and locking up.

06. The fuselage is shown with the radio compartment complete and the tail joined. The light plywood battery floor aids in bringing the nose together with the proper contour. Tape the battery floor and F1 in place and ensure alignment before gluing.

07. Balsa rails and a central divider on the battery mount floor ensure good airflow. The side rails have not yet been installed. The rear stop on F2 can be removed to move the batteries aft.

08. This is the completed nose gear and belly block. This area should be fiberglassed.

09. Be sure to use two mounting straps because of the batteries' weight.



10. The oversize aileron servo compartment opens to allow cooling air to exit.

with a sheet of 1/2-inch balsa. A triangle cutout at each upper corner of F1 is for the 1/4-inch triangle balsa piece on the upper edge of the battery compartment so that the nose can be carved to the proper contour. Glue these in.

A large channel should be cut out of the lower 3/8-inch sheet for airflow. This will make it two separate sides.

Use only enough material for the outer upper side contour of the fuselage and tack it into place on the top edge of the fuselage sides. Now permanently glue the upper 1/2-inch sheet to the lower one. When it is dry, it can be carved and sanded. The nose block shows the bevel that should be used on the hatch. This will allow the hatch to tip away from the rear canopy as it comes up and forward.

The battery hatch has longitudinal strips on the floor and sides to hold the batteries in place and allow cooling to all sides. They are not shown on the plans but can be seen in the photos. I first used two 3,700 mAh batteries with a tall center balsa strip to separate them and allow air to flow between them. When I changed to 4,100 mAh batteries, the strips were removed and the batteries were touching each other but they still remained cool.

I used only the front of the canopy. It slants downward with the 5/16-inch slope of the hatch so the contour at the separation point is altered. To get a good contour, a wood rear canopy with a pleasing contour was designed. Use the cross-section shown on the original Dirty Birdy plans. The concavity between the canopy and fuselage top is designed to trap airflow and assist in knife-edge flight.

Hollow this wood canopy as close to 1/8-inch thick as possible. The nose block should also be hollowed to 1/8 or 3/16 inch. Two blocks were laminated for the nose so that the seam could be placed on the aircraft's centerline and used as a reference line in carving.

A large inlet at the top of the nose block is for cooling air. Another could be placed in the belly behind the nose gear but the aircraft doesn't seem to need it. All other fuselage construction is standard.

This article is about the modifications needed to create your own e-Dirty Birdy twin. Things not covered are standard procedures used with most wood construction and illustrated on the original plans. I have included wing and stabilizer rib outlines because they are not shown on the original kit plans.

Because this is a wood model, weight management is imperative. Use lightweight wood where strength is not critical, keeping in mind that this airplane will not have the vibration inherent in a glow-powered model. Extensive lightening holes were cut into the ribs, especially outboard of the nacelles.

My glow-powered Dirty Birdy weighed 7.25 pounds. The twin is 8 pounds (the dual batteries are nearly 2 pounds). Eight pounds is typical of a vintage Dirty Birdy, and with adequate power, it will fly well at this weight with these motors and the increased lift from higher-speed airflow over the inner wing.

Weight in the tail surfaces is not an issue. I added 2 ounces at the rudder hinge line to balance the batteries.

The Polyspan finish has six coats of clear dope. Most of the flying surfaces were left clear to decrease weight. Iron-on film would be fine for this project.

Both 3,700 mAh and 4,100 mAh dual LiPo batteries have been used in the prototype. A wiring harness brings the current from the batteries together in parallel, and then separates it to go to the two ESCs. The ESCs in effect "read" one 7,400 mAh or 8,200 mAh battery and cut off at the same time. No spin and crash on the landing approach!

Flight times are 9 to 10 minutes. A single battery in the 6,000 mAh range will save weight but sacrifice flight time. If you choose to do this, make the lead from the battery to the Y harness from 10-gauge wire and from the Y harness to the ESCs from 12-gauge wire. Two ESCs are drawing twice the current from one battery and the wires could overheat or components could malfunction.

Flying

As I write this, the twin has made 44 flights. Takeoffs and landings are smooth as silk. Upon takeoff, ease the throttle to roughly half and hold slight up-elevator. It will smoothly fly itself off with no jump or yaw. In most maneuvers, the Dirty Birdy tracks as if it is on rails, without right or left yaw in hard climb or dive maneuvers. Knife-edge flight is better with less fuselage angle of attack because of the lifting nacelle design and the increased propeller disc area.

At first I had a little difficulty performing slow rolls and four-point rolls. When the aircraft rolls, one propeller is rotating into the roll while the other is resisting. The second force is the inertia of the power package that is located laterally in the wing at a distance from the center of gravity. The degree to which these forces manifest is directly related to airspeed, propeller speed, and roll rate. As you become accustomed to the airplane, it becomes easier to correct for or avoid these effects.

In using pairs of both 3,700 mAh and 4,100 mAh batteries, another solution became evident. When I used the lighter batteries, the rolls improved, but spin entry was not as good. The 4,100 mAh batteries give consistently good spin entry and exit, but the rolls are not as clean.

This problem is not unique to a twin-engine aircraft. Some have tried using a tray with weight shifted by a servo to address this issue. There is likely a CG "sweet spot" that I haven't yet looked for. If "pattern perfect" spins don't matter, keep the nose lighter for good rolls.

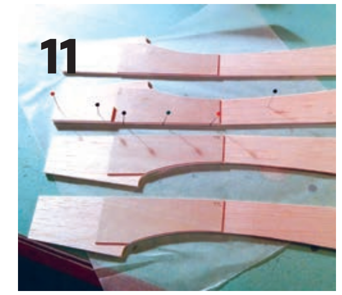
I started with down-and-in propeller rotation, which means that as the propeller passes near the fuselage, it is going down. That is full-scale practice and seems to help with one-engine-out situations. That isn't as much of a concern with electric power. Changing to up-and-out seems to have improved roll handling as well (different spiral airstream presentation).

At first I was disappointed with the flying speed provided by the 10 x 5 propellers. I am used to .61 glow engines and a long turnaround flight pattern to keep speed up for large vertical maneuvers. That kind of speed is not needed with electric power—especially with a twin. You can fly slower and instant climb is available when needed.

I've compressed my flight pattern and am stringing maneuvers together in continuous action. An example is the rolling eight (a vertical eight that begins in the middle) immediately superimposed with a knife-edge eight (horizontal plane line) at the central intersection. This combined maneuver does not need to be big and fast. The Dirty Birdy will do it smaller and slower.

My transmitter is set for 9.5-minute flight times and I usually have 15.1 volts left. That could be increased to 10.5 minutes with no problems. I keep the batteries in pairs so there is no mismatch in usage or charging patterns. The batteries barely get warm. Be sure to build with the cooling features as designed, especially the rails on the sides and bottom of the battery compartment for airflow.

The e-Dirty Birdy twin is truly one of a kind—until you build yours.



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11. There are right and left nacelles and right and left sides for each. Exercise care and be sure to mark the parts.

12. The hatch cover is laminated from two sheets of balsa. The sheet on the inside is mostly hollowed out to increase airflow.

13. Two 4S 4,100 mAh batteries are wired in parallel and mounted in the nose. They can be individually adjusted to attain the correct CG. An arming plug is suggested for safety.

NACELLES:

The nacelles are designed to maintain the original down thrust of the Dirty Birdy. The rear is squared off for two reasons. Too much area forward of the CG can cause yaw instability which is balanced by are behind the CG and this geometry assists knife-edge flight. The following procedures are intended to give exact alignment of the two motors, which is of course dependent on a wing with no twist.

Make one outer nacelle side as accurate as possible. A copy of the plan can be laid face down over the wood and heated with an iron. This will leave an image that is easy to cut accurately. Make a duplicate by pinning the first side to another piece of wood and cutting and sanding to make them exactly the same. Then use each outer side to again make duplicates for inner sides. The only difference is more cut-out for the wing sweep at the L.E. Do not use one side as a pattern for the other three as you will sand more off with each use creating inaccuracy. Now make four identical 1/32 ply doublers. Make a 1/8 balsa spacer the length from the front of the nacelle sides to where each firewall mounts. Use this same spacer on each nacelle side to position all four doublers for gluing. Be sure you make a right and left nacelle, each with an inner and outer side. Make two each identical N1's and N2's. All sides should be square and width should be 2 inches. Carefully glue N1 in place on the inside surface of the ply doubler flush with the front of the doubler, not in front of the doubler on the balsa side. Use a square block to align while gluing. Repeat with N2. Now glue the correct other side to the remaining open ends of N1 and N2. It is easier to tape and pin these parts in position while holding them in space and checking with a small square before gluing than to do it on the plan. Add 1/4 triangle reinforcement behind the N1 joint and glue well with epoxy fillets. A carveable balsa doubler will be glued in front of N1 locking it in place.

Make three parallel lines one inch apart on paper. Pin the nacelle upside-down with the inside surface of each doubler touching the outer lines. Insure everything is square. (Note: the front upper edges of the nacelle sides are parallel to the thrust line giving two degrees down thrust. The rear upper edges of the nacelles are parallel to the airfoil center line, thus the entire assembly will not lay flat. Pack up one end if desired.) The rear of the sides may now be joined over the center line, making sure they are perpendicular to the work surface. Balsa blocks are good to ensure alignment. Use pins and paper clamps to hold and run thick CA on the inside of the joint. The remaining work is adding top and nose blocks and the hatch. It' standard and self explanatory.

MOUNTING THE NACELLES:

Mount the wing to the fuselage and determine how much prop clearance you want. The plan shows clearance for a ten inch prop. Measure out from the fuselage sides and establish a common point for each nacelle. Now establish a line perpendicular to the T.E. across the chord for the center line of the nacelle to be positioned over. A flat template bent over the curve of the wing will deviate slightly. This does not matter as long as you do the exact same for both sides. Place the nacelles on the wing, pinning them in place centered over the lines with the wing cutouts snug to the L.E. Triple check all alignments including to the fuselage. Do not sand the cutouts for the airfoil and do not force the nacelles down. Let them sit naturally and tack where there is contact when satisfied. This can be followed with a generous epoxy fillet which will bridge any small gaps. If you have done all this accurately your motors should line up with each other and the fuselage. You may of course use laser meters or other devices to check from the motor shafts.