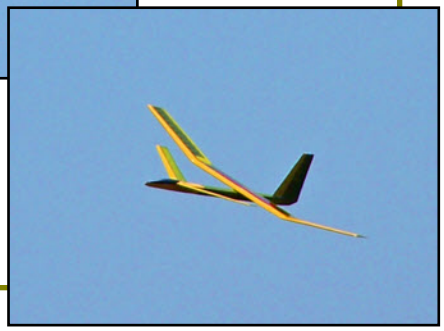
CANARROW

Calculated Data

Main Wing:	Span:	2 meters
	Area:	580 square inches
	Airfoil:	S3021 (Modified at tip)
Canard:	Span:	1 meter
	Area:	172 square inches
	Airfoil:	S3021 (modified)
Total lifting area:		752 square inches
Target flying weight:		40 ounces or less
Loading at 40 oz:		7.66 oz./sq. ft.



CANARROW BUILDING GUIDE

MAIN WING

General Description

The main wing is conventionally built with an I-beam spar, "D-tube" sheeting ahead of the spar and open bay construction behind it. All sheeting is 1/16" balsa with span-wise grain. The spar is full-depth to keep the caps as far apart as possible. Accordingly, the D-tube sheeting does not overlie the spar, but merely butt joins the forward sides of the spar caps top and bottom. The spar sheer webs are vertical-grained balsa with a minimum thickness requirement of 3/16". (NOTE: The webs in the short kit are 3/8" thick and taper in the direction of the part number writing)

The trailing edge is solid balsa. Commercially available 1" trailing edge stock must be planed to the thickness of the ribs. This should be done before the trailing edge is installed. For the center section, this is the thickness at the back of rib "2." There is limited sheeting behind the spar to provide ease of handling/covering and additional rigidity at the dihedral break. Lower surface sheeting behind the spar is made from 1/16" balsa cut to fit into the bays between the ribs, spar and trailing edge. All upper surface sheeting overlies the ribs and butt joins the spar and trailing edge. Reinforcement of the rib/trailing edge joint is optional using small right triangles of 1/8" balsa.

The following bays are sheeted behind the spar: Upper surface – middle three bays and the bays immediately adjacent to the dihedral breaks on both sides of the breaks (7 bays total – ribs "1" and "3" are profiled to account for this sheeting); lower surface – middle three bays and bays immediately adjacent to the dihedral break but only on the center section sides of the breaks (5 bays total – there is no lower surface sheeting outboard of the dihedral break).

Construction Sequence

If building the balsa/carbon spar option, use (minimums) 0.014" carbon for the center section cut to 3/8" width and laminated to the spar using a thin, slow-cure epoxy. The outer panel spars can use 0.007" carbon (NOTE: The carbon must be on the outer sides of the spar caps – take care while laminating to make a top and bottom spar for each tip panel) Cure under compression. After curing, sand the laminated spar back to its original dimensions of 3/8" x 3/16".

Starting with the center section. If a spoiler will be used, relief for the spoiler panel can be cut prior to construction or afterwards. Glue up the bottom spar, ribs, webs and upper spar with everything pinned in its correct position and pressed flat to the building board. Do not install the outermost ribs (rib "1") at the dihedral breaks; these are cut to accommodate the dihedral braces and later installed at an angle against the back of the braces.

Also at this time install all four of the 1/32" ply dihedral braces. Before installing the dihedral braces, draw a reference line from top to bottom of each brace showing the dihedral angle (the middle of the "V"), which will be visible from the front and back of the spar after the braces are installed. The inboard bottom of each brace should be flush with the building board. Center the braces at the dihedral breaks. This line is

Center section structure without upper surface sheeting.

used to locate the braces on the spar and to align the cut rib "1s" later. Trim the upper spar so it ends at the dihedral break. Do not install the leading edge, trailing edge or any sheeting at this time if using the balsa/carbon spar or if the spruce spar will be wrapped with tow. If the spar will not be wrapped, the leading edge, trailing edge and the lower surface sheeting behind the spar can be added without delay.

If using the balsa/carbon spar option, the spar must be wrapped with carbon or Kevlar tow to prevent de-lamination of the carbon from the balsa under load. The spruce spar can also be wrapped for additional strength. There should be a gap of no more than 1/8" between wraps on the center section (and no more than 3/16" between wraps on the tip panels). Start at one end of the center section and wrap around the dihedral braces. The wraps should be snug. After wrapping, seal the fibers of the tow using either a thinned epoxy, thin CA or model airplane dope. Return the center section to the building board after the spar has been wrapped. Cantilever the spar over the side of the board to prevent the thickness of the tow from interfering with true construction. Install the leading and trailing edges.

Take the 4 unused rib "1s" and cut out the spar areas from each. Cut across each rib 1/32" ahead of and 1/32" behind the spar cut-outs. Glue the resulting front and rear rib parts together to form two double-thickness ribs (a front and a back half of each). Install these doubled rib "1" halves between the spar dihedral braces and the leading/trailing edges. Center the forward rib halves on the spar; the aft rib halves are flush with the bottom of the lower spar but 1/16 lower than the top of the upper spar.

Double ribs "1" at dihedral break showing surface sheeting overlapping inner ribs only.

Angle the rib halves so the middle of each is aligned with the dihedral angle line previously drawn on the faces of the dihedral braces. (NOTE: Only the inner half of the doubled ribs is connected to the center section leading and trailing edges. The outer half will eventually be glued to the leading and trailing edges of the tip panels when they are joined) Install all lower surface sheeting aft of the main spar. **Do not install any upper surface sheeting at this time.**

After all of the above is cured/dry, pull the center section from the building board. Carve the 1/8" square leading edge to shape. Install only the lower surface sheeting of the D-tube. This sheeting extends to cover only one half of the doubled rib "1s" at the dihedral breaks. The other half of those ribs will accept sheeting on the tip panels.

The wing and canard are mounted using nylon bolts to ensure accurate placement. In the flying surfaces, these bolts pass through mounting blocks made from a sandwich of scrap balsa capped with ply (1/32" ply is recommended) measuring 3/4" by 1 7/8" and spanning the middle rib bay. The ply reinforces the lower surface sheeting on the bottom side (in the event a bolt sheers, it will not tear up the sheeting) and on the upper side it accepts the loads from the bolt head. This sandwich is flat top and bottom, and should not follow the contour of the ribs. Make the sandwiches as deep as possible so the top ply surface comes up to the top of the ribs but does not exceed their contour. The forward mounting block is also glued to the front of the spar. Install the mounting blocks and drill the

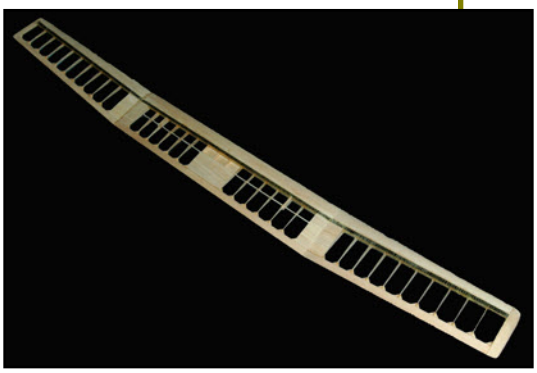
Center section showing all lower surface sheeting, dihedral braces, balsa/carbon spar with Kevlar tow and mounting blocks.

bolt holes. Center the holes on the blocks, and drill through the bottom of the lower sheeting.

After completing the above, install the upper surface sheeting. Do not attempt to glue the upper surface sheeting to the wing attachment blocks, which are flat and should lie immediately below the sheeting. As with the leading and trailing edges, the upper surface sheeting only covers one half of the outermost ribs (the cut and doubled rib "1s"); Sheeting from the outer panels will use the other half of those ribs. After the upper surface sheeting is on, complete preparation for the nylon mounting bolts by carefully drilling from the bottom of the wing through the upper surface sheeting. It is recommended this be done with the drill bit manually to avoid tearing the skin. Now install the nylon wing bolt from the top. Carefully cut around the head of the bolt through the upper surface sheeting. After removing the cut out skin, the head of the nylon bolt will pass though the enlarged upper surface hole and seat squarely against the top of the mounting block ply. If the top of the mounting block is just below the surface of the skin, the head of the nylon bolt will be recessed and flush with the skin.

Finished mounting bolt holes showing relief for bolt heads in the upper surface sheeting.

The outer panels are conventionally built in the same manner as the center section. They must be mounted to the center section before the D-tube sheeting is installed. Test fit the panels, and trim the upper spar as needed for the dihedral angle. The dihedral braces bend aft slightly and must be clamped while the adhesive is curing. The dihedral angle calls for the bottom of the outermost rib to be 5" above the building board with the center section flat on the board. The bottom of the lower spar should be flush with the bottom of the dihedral braces in this position. The leading and trailing edges of the tip panels should abut those of the center section, and proper alignment is made by centering them on the unused halves of the doubled rib "1s" at the dihedral breaks. After joining the panels, install the tow before adding the D-tube sheeting and tip blocks if the spar will be wrapped.



Complete wing structure with tip blocks.

CANARD SURFACES

General Description

The canard is the most complex structure on the airplane. It is built as three separate pieces: Left, center and outer panels. These are butt joined together and the joints are reinforced with fiberglass tape. The center section is completely sheeted and can either be permanently fixed to the fuselage or removable using one nylon bolt in the manner described above for the main wing. Each outer panel uses a single lower spar and a fully sheeted upper surface with no sheer webbing between them. Actuation of the elevators is complicated by the fact they move in different planes. There are two proven methods, and one must be chosen before starting construction. The preferred method is to use small servos (Hitec HS-65 or equivalent) mounted in each outer panel behind the lower spar in the bays immediately outboard of the center section (these are the only bays with lower surface sheeting). Using this option, the servos are mounted at an angle, with the arm aligned perpendicular to the hinge line. The

servos may protrude slightly below the bottom surface when mounted. Actuation of the surfaces is accomplished by a short, straight link to the control horns, which are also aligned normal to the hinge line. The servo wires pass through small holes into the center section of the canard. This set-up requires either a computer radio to mix elevator responses to the two servos or a "Y" harness. The second method uses a three horned torque tube roughly 2 1/2 inches long, which spans the center section and extends one horn through the bottom of each of the middle three bays (center section and inner bays of each outer panel). The torque tube is driven by a single, larger servo mounted under the center section (Hitec HS-85 or equivalent), and the elevator surfaces are connected by ball links to the outer horns of the torque tube. This method is cleaner since only the control horns extend into the airflow and all of them are aligned with it. However, the torque tube is more difficult to build. The tube must be suspended in bushings. Use a carbon fiber rod for the torque tube, ply for the arms, and aluminum tubing for the bushings.

Construction Sequence

Starting with the center section, glue up the center spar (balsa is sufficient) with the dihedral braces labeled "center" on the front and back sides of the spar and ribs "a" abutting the edges of the braces. Make sure everything is square. Install the leading and trailing edges. The lower surface sheeting is cut to fit into the open bays in the same manner used for the wing. Do not install the upper surface sheeting at this point.

Canard center section structure with mounting block (two servo method).

Frame up both outer surfaces. Install the four dihedral braces with the "in >" markings pointing toward the center section with the writing right side up. Ribs "b" are angled to abut the edges of the braces on both panels. Carve the 1/4" x 1/4" balsa leading edges to shape before installing the lower surface sheeting. Lower surface sheeting is installed only in the bays closest to the center section between ribs "b" and "c." This is done in the same manner as on the wing by cutting scrap balsa to fit into the bays with the grain running span-wise. Use 1/16" balsa behind the spar and 3/16" balsa ahead of it. The 3/16" blocks are installed flat and sanded to match the contour of the lower ribs when dry.

All five canard structures (two servo method) without any upper surface sheeting.

If the center section will be removable, make a balsa/ply mounting block in the same manner as used in the wing. This is mounted behind the center section spar and glued directly to the aft dihedral brace. Install the center panel upper surface sheeting and wrap the section joints with fiberglass tape. Make sure the tape does not overlap on the lower surface so it remains perfectly flat.

If using the two servo method, cut holes for the servo wires (in ribs "a" and "b") and sheet the upper surfaces of both outer panels before joining the sections together. Cut openings for the servos in the lower surface sheeting behind the spars before joining the sections, and ensure proper orientation for coordinated movement if using a "Y" harness. Servo installation is done after the model has been covered. Join the outer panels to the center section. The outermost ribs should be 3" above the building board with the center section flat on the board. Cut a hole in the lower aft skin of the center section to allow the servo wires to pass into the fuselage. If the canard will be removable, make sure this hole

will not interfere with the canard mounting hardware, including the maple block located in the fuselage

If using the torque tube method, all three sections must be joined before any upper surface sheeting is installed, but the lower surface sheeting must be installed and slots for the three control horns must be cut before joining. After the sections have been joined, cut "U" shaped channels into the tops of ribs "a" and "b" to accept the aluminum bushings. Install the torque tube and ensure it moves freely. Install the upper surface sheeting on the outer panels.

After the three sections have been assembled and finish sanded, reinforce the dihedral breaks

Complete canard structure ready to cover showing tip blocks and fiberglass reinforcement at dihedral breaks.

with fiberglass. **IMPORTANT: Do not omit this step.** The upper skins of the canard act as its upper spar, and loads must transmit safely to the center section. Under positive G loadings, the upper skins of the outer panels (under compression) will attempt to under-ride that of the center section. Should this occur, the structure will fail. The preferred method of reinforcement is to wrap the entire center section twice in light fiberglass using laminating resin. The first wrap should extend one half inch beyond the dihedral breaks, and the second layer should extend to rib "c," which is two inches from the break. Laminate top and bottom. Sand between layers and change the orientation of the glass weave.

VERTICAL STABILIZER

General Description

The vertical stabilizer is the simplest structure on the airplane. The only thing not immediately obvious from the plan is that the entire structure is sheeted in 1/32" vertical grained balsa. Without sheeting, the vertical stabilizer is easily damaged.

Vertical stabilizer internal structure before addition of right side sheeting.

IMPORTANT: The main vertical spar cannot be made of plain balsa (as noted on the plan) or it will fail. Spruce is the preferred material, but balsa/carbon can be used.

FUSELAGE

General Description

The fuselage is a stressed skin monocoque using 1/16" balsa based on a 2" x 2" cross section. The sides are 1 7/8" tall and 48" long. The top and bottom surfaces overlie the sides, and the edges are chamfered. The corners are reinforced with triangle stock balsa. For C.G. reasons, the battery and rudder servo are mounted in the farthest aft compartment behind the fourth "D" former. When the fuselage is complete, this compartment is sealed, and those components are not accessible. Only the receiver and switch harness are mounted in the accessible nose section.

Construction Sequence

Start with the fuselage sides. These must be cut accurately to ensure the wing and canard wind up being in the same plane when everything is

finished. Get a good, metal straight edge at least 48" long. Do not trust that the edges of commercially cut stock are straight. Both side panels can be cut from a single 4" x 48" balsa sheet even after truing of the top and bottom of the sheet.

After the sides are cut, the forward ply doublers are installed. Draw a vertical line 3/16" behind the nose on the inside of both side panels. Align the tops of the doublers with the tops of each side panel and the front of the doublers with the line. Make sure you are building a left and right side panel and not two copies of one side. After curing/drying, remove the excess balsa from the canopy area above the doublers. Install the triangle stock balsa. This does not extend forward of the front of the ply doublers (3/16" from the end of the nose). The triangle stock should also end 3/16" from the tail end of each side. NOTE: Cut relief into the upper triangle stock to allow for the ply fuselage doublers.

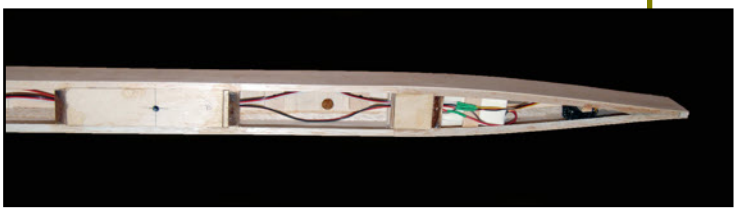
Mark the locations for formers "B," "C," and all 4 "Ds" to both sides and install them in a single gluing step using a slow curing epoxy.

Basic fuselage structure showing sides, all formers, tail stock and ply mounting plate for tow hook.

Apply clamps or rubber bands to the outer fuselage sides at the positions of each former. Before curing, place the fuselage upside down on the building board and apply weight so the upper surfaces are aligned in the same plane. Ensure proper alignment and allow to cure.

After the initial frame-up, install the nose former ("A") and tail stock (3/8" x 3/16" balsa). Be sure no twists are induced, especially at the tail, so the vertical stabilizer will be perpendicular to the wing. NOTE: The triangle stock must be tapered at the tail. Install the upper surface sheeting. Cut out the canard platform floor with 1/16" cross grained balsa but do not install it yet. Add a double sheet of balsa under the wing with grain running perpendicular to the adjacent wood.

Trial fit the main wing to the fuselage. Secure it in its correct location with masking tape



Bottom of fuselage with upper sheeting on. Main wing mounting blocks, spoiler wire access hole, battery and rudder servo are in place.

(trailing edge 10" from fuselage end and square with the fuselage center line). Using the mounting holes already in the wing, drill through the top of the fuselage. Install the threaded maple blocks inside the fuselage with white glue or epoxy. Use the nylon bolts to hold the blocks in place while drying. If the canard will be removable, install it in the same manner.

Do not attach the canard mounting surface until after proper alignment of the wing and canard is confirmed. Bolt the main wing to the fuselage using the nylon bolts. Place the 1/16 inch cross-grain balsa canard mounting surface in its place and tape the canard surfaces in place over it. Measure the alignment of the canard carefully against that of the wing to ensure there are no twists in the fuselage. Trim the fuselage sides below the canard mounting surface as required to ensure correct alignment. After ensuring proper fit, glue in the mounting surface and its reinforcing doubler from below and gusset the joint with triangle stock balsa. Install the canard mounting bock as described above for the main wing.

If using a spoiler, install the wing and cut a hole through the bottom sheeting of the wing into the fuselage to allow the spoiler servo wires to pass through.

Cut the fuselage bottom panel to shape. Install the 1/8" ply doubler for the tow hook. Install the tow hook. Install the rudder servo after cutting a slot for its arm. The servo is glued directly to the fuselage side wall, which should be locally reinforced with a 1/16" balsa or 1/32" ply doubler under the servo. Using scrap balsa, brace the servo against the opposite fuselage side wall for additional support and to remove any flexing. Install the battery in foam against the back of the aft most former "D" and brace it so it cannot move. Install the radio gear, including the receiver and test the operation of the rudder servo. NOTE: Wires for the battery, rudder servo and spoiler and the receiver antenna (72 MHz) all run nearly the length of the fuselage and cannot be accessed after the bottom panel is installed.

After ensuring the battery is fresh and holds its rated charge and everything is aligned and working properly, install the fuselage bottom panel. Chamfer the corners (except at the extreme aft end where the vertical stabilizer is joined). Cut former "Aa" so that it is located near the middle of the nose bay and ahead of the receiver. Install the nose block. Carve the canopy. The final step is to install the vertical stabilizer and rudder to the end of the fuselage. Sand the fuselage sides so they match the thickness of the vertical stabilizer.

FINAL ASSEMBLY

Cover the model and install the remaining radio gear. The receiver goes in the nose compartment. I put the switch there too. Balance the model at the recommended point as accurately as possible.

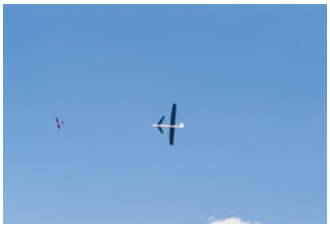
Recommended control throws are 30 degrees up/down (elevators) and 45 degrees left/right (rudder). The elevators move "down" for a nose "up" command and vice versa. The rudder and spoiler move conventionally.

PROTOTYPE GALLERY

Canarrow 1 prior to first flight. Fuselage was three inches deep with drooping nose. Original small tail proved inadequate.

Canarrow 1 with revised large tail. All radio gear was in nose requiring a lot of balancing weight in tail. Flying weight was 67 oz. Model handled well but was eventually folded on a winch.

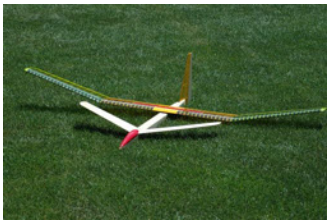
Canarrow 2 showing revised two inch square fuselage with battery and rudder servo in rear. Flying weight was 45 oz. Model was ultimately shot down on 72 MHz and wreckage never found.



Canarrow 2 in flight. All airfoils were S3021 with upper surface sheeting/cap strips, open bay lower surfaces, and spruce/carbon spars.

Canarrow 3 - extreme weight savings. All sheeted surfaces doped. Sheeting on main wing and tail deleted. Single servo elevators. Flying weight was 32 oz.

Main wing had sub-ribs between balsa/carbon spar and carbon tube leading edge. All airfoils S3021.



Model flew well but fluttered at even moderate speed leading to final re-design with D-tube wing and airfoil modifications.

CANARROW SHORT KIT PARTS LIST

Qty.	Disc.	Use
MAIN WING		
☐ 4	1/8 x 1/8 x 36 balsa	Wing leading edges and spoiler framing
☐ 6	3/8 x 3/16 x 36 balsa/carbon or spruce	Main wing spars 0.014 carbon center/0.007 carbon tips
☐ 3	1 x 36 balsa trailing edge	Main wing trailing edge – must be planed
☐ 1	2 x 36 balsa aileron stock	Spoiler panel – trim leading edge to fit
☐ 7	1/16 x 3 x 36 balsa	Sheeting
☐ 1	1 x 2 x 12 balsa block	Tip blocks (should also make canard tips)
☐ 1	Kevlar or carbon tow	Spar wrapping (Optional with spruce spars)
CANARD		
☐ 2	1/4 x 1/4 x 36 balsa	Leading edge
☐ 2	3/8 x 3/16 x 36 balsa/carbon or spruce	Lower surface spar Spruce is preferred, but balsa/0.007 carbon is optional
☐ 2	1/16 x 3 x 36 balsa	Upper surface sheeting/lower surface aft spar
☐ 2	2 x 36 balsa aileron stock	Moving surfaces
☐ 1	1/8 x 1 x 36 balsa	Aft spar vertical surface/hinge carrier
FUSELAGE		
☐ 2	1/16 x 4 x 48 balsa	Fuselage sides, top and bottom
☐ 1	21/2 x 2 x 12 balsa block	Canopy
☐ 1	1 x 1 x 11/2 pine/spruce	Nose block
☐ 6	1/4 x 1/4 x 7/16 balsa	Triangle stock corner reinforcement
☐ 1	2 x 2 x 6 birch plywood	Tow hook mounting platform
VERTICAL STABILIZER		
☐ 2	3/8 x 3/16 x 36 balsa	Exterior framing
☐ 1	3/16 x 1/8 x 36 balsa	Interior framing
☐ 2	1/32 x 4 x 36 balsa	Sheeting
☐ 1	2 x 36 balsa aileron stock	Moving surface
HARDWARE/RADIO GEAR		
☐ 1	10 Pack of 1/2A hinges	Canard and rudder surface hinges (CA hinges also an option)
☐ 2	2 Pack of 1/2A control horns	Canard and rudder surfaces
☐ 1	Tow hook	Can be made from a 4-40 threaded rod
☐ 3	Push rod/clevis sets	Elevator and rudder linkages
☐ 1	500 mAh battery	Flat or square pack will fit
☐ 1	Receiver	4 channel minimum. Full sized unit will fit
☐ 1	Switch/charging harness	
☐ 4	Sub-micro servos	Hi-Tec HS-65 or equivalent (2 servo canard method)
☐ 1	Deans 3-pin connector	Disconnect for spoiler servo
☐ 2	Deans 4-pin connector	Disconnect for canard servos (2 servo canard method)
☐ 1	"Y" harness (optional)	For canard surfaces if using a non-computer radio
☐ 3	1/4 x 20 nylon bolts blocks	Main wing and canard hold downs