HANGAR 9®

WE GET PEOPLE FLYING

46%

TOC Ultimate 10-300

ASSEMBLY MANUAL

Specifications

Wingspan	100 in (2540 mm)
Length	110 in (2794 mm)
Wing Area	3310 sq in (213.5 sq dm)
Weight	40–44 lb (18–20 kg)
Engine	150–200cc gas engine
Radio	6-channel w/15 servos

Introduction

Thank you for purchasing the Hangar 9® 46% TOC Ultimate. Because size and weight of this model creates a higher degree for potential danger, an added measure of care and responsibility is needed for both building and flying this or any giant-scale model. It's important that you carefully follow these instructions, especially those regarding hinging and the section on flying.

Like all giant-scale aerobatic aircraft, the Hangar 9® TOC Ultimate requires powerful, heavy-duty servos. Servos greatly affect the flight performance, feel and response of the model. To get the most out of your Ultimate, it's important to use accurate, powerful servos on all control surfaces. In the prototype models, we used JR 8411 digital servos with excellent results. A less powerful servo can lead to a crash. The Hangar 9® TOC Ultimate does not include hardware. Many experienced giant-scale pilots have specific hardware preferences and can individually choose the components they prefer.

Throughout the manual, we give hardware recommendations. If using another type/brand of hardware than recommended, be sure that it's strong enough for this application and properly installed. If you encounter difficulty in any construction sequence, please contact one of our technicians. We can provide assistance concerning the construction of your Hangar 9® 46% TOC Ultimate 10-300.

Additional Required Equipment

Radio Equipment

- 6-channel radio system (minimum)
- Receiver (JRPR955S or JRPR945S recommended or equivalent) (1 or 2)
- 1 standard servo (JRPS537 recommended or equivalent)
- 14 digital ultra torque servos (JRSDS8411 recommended or equivalent)
- JR MatchBox™ (JRPA900) (5)
- JR Charge Switch (JRPA004) (3)
- 6" Aileron Extensions (JRPA095) (4)
- 12" Heavy-Duty Servo Extension (JRPA098) (6)
- 18" Heavy-Duty Servo Extension (JRPA099) (8)
- 24" Heavy-Duty Servo Extension (JRPA102) (6)
- Y-Harness (JRPA133) (2)

Recommended JR Systems

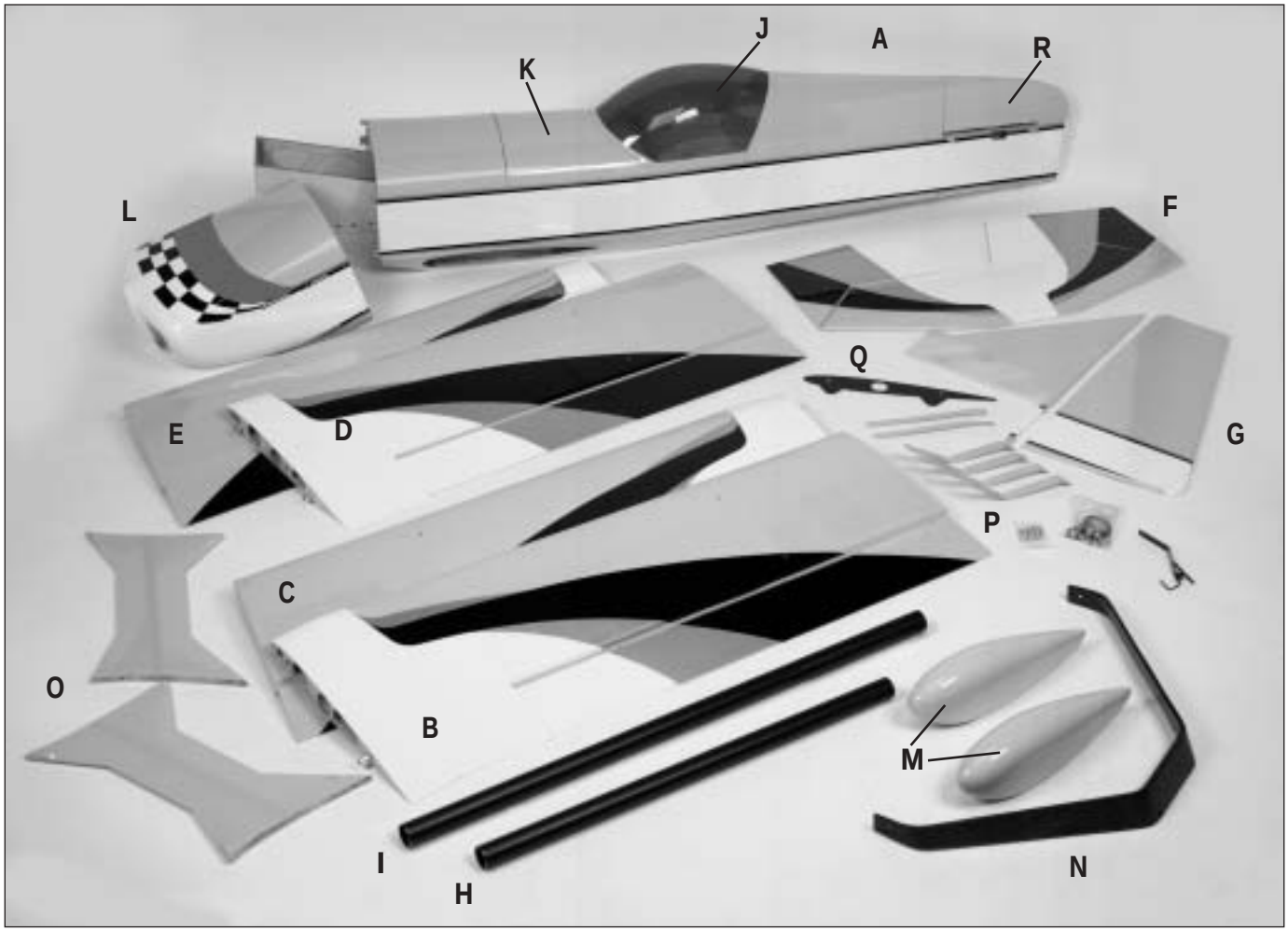
- JR XP8103
- PCM 10X

Engine Requirement

- 150–200cc gas engine

Table of Contents

Contents of Kit



A. HAN1101	Fuselage w/Hatch	K. HAN1111	Canopy Hatch
B. HAN1102	Right TOP Wing w/Aileron	L. HAN1112	Painted Fiberglass Cowl
C. HAN1103	Left TOP Wing w/Aileron	M. HAN1113	Fiberglass Wheel Pant Set
D. HAN1104	Right BOTTOM Wing w/Ailerons	N. HAN1114	Carbon Fiber Landing Gear
E. HAN1105	Left BOTTOM Wing w/Ailerons	O. HAN1115	Outer Wing Strut Set
F. HAN1106	Stabilizer w/Elevators	P. HAN1116	Painted Aluminum Cabane Strut Assembly
G. HAN1107	Fin/Rudder Set		
H. HAN1108	Aluminum TOP Wing Tube	Q. HAN1117	Carbon Fiber Cabane Center Rib
I. HAN1109	Aluminum BOTTOM Wing Tube	R. HAN1118	Tail Fin Block
J. HAN1110	Canopy		

Warning

An R/C aircraft is not a toy! If misused, it can cause serious bodily harm and damage to property. Fly only in open areas, preferably at AMA (Academy of Model Aeronautics) approved flying sites, following all instructions included with your radio and engine.

Additional Required Tools and Adhesives

Tools

- Canopy Scissors
- Clamps
- Drill
- Drill bit: #44, 1/16", 1/2", 1/8", 11/64", 3/16". 3/32", 5/16", 5/32", 5/64", 9/64"
- Hex wrench set
- Hinging tool
- Incidence meter
- Phillips screwdriver
- Pro-Link Wrench (HAN3558)
- Razor saw
- Rotary tool w/sanding drum
- Ruler
- Scissors
- Socket wrench
- Square
- Tap handle
- Tap: 4-40, 8-32
- Tape measure
- Wrench

Other Required Items

- Mixing sticks for epoxy
- Epoxy brushes
- Denatured alcohol
- Sanding bar
- Sandpaper (medium)
- Paper towels
- Wax paper
- Felt-tipped pen or pencil
- Measuring device (e.g. ruler, tape measure)
- T-pins
- String
- Radio packing foam

Adhesives

- Thin CA (cyanoacrylate) glue
- Thick CA (cyanoacrylate) glue
- CA remover/debonder
- 6-minute epoxy
- 30-minute epoxy
- Pacer Z-42 Thread lock
- Canopy glue (R/C-56)
- Masking tape (3M blue recommended)

Other Items Needed (not included in the kit)

- Propeller (consult your engines instruction manual)
- Large servo arm (JRPA212) (2)
- 6" Ultimate Spinner
- 4 1/2" Hangar 9 Pro-Lite Wheels (HAN309)
- 1 1/2" Hangar 9 Pro-Lite Wheel (HAN300)
- Tail Wheel Bracket
- 8-32 Control Horns (HAN3614) (12)
- 4-40 Ball Links (HAN3616) (30)
- 4-40 Double Ball Links (HAN3619) (6)
- 4-40 Full Servo arms (HAN3576) (4)
- Rudder bellcrank (optional)
- Elevator 3D Servo Arm (HAN3579) (2)
- Aileron Servo Arm (HAN3574) (8)
- Throttle Servo Arm (HAN3531)
- 4-40 x 3 1/2" Titanium Pro-Link (HAN3554) (10)
- 4-40 x 4" Titanium Pro-Link (HAN3555)
- 4-40 x 1 1/2" Titanium Pro-Link (HAN3550) (8)
- 50-ounce fuel tank
- Tygon fuel tubing
- Civilian pilot

Before Starting Assembly

Before beginning the assembly of the Ultimate, remove each part from its bag for inspection. Closely inspect the fuselage, wing panels, rudder, and stabilizer for damage. If you find any damaged or missing parts, contact Horizon Product Support.

If any wrinkles in the covering, use a heat gun and covering iron to remove them. Use caution while working around areas where the colors overlap to prevent separating the colors. Start with a low heat setting and gradually work up to the optimum working temperature.

Using the Manual

This manual is divided into sections to help make assembly easier to understand and to provide breaks between each major section. Take your time and follow the directions.

Warranty Information

Horizon Hobby, Inc. guarantees this kit to be free from defects in both material and workmanship at the date of purchase. This warranty does not cover any parts damaged by use or modification. In no case shall Horizon Hobby's liability exceed the original cost of the purchased kit. Further, Horizon Hobby reserves the right to change or modify this warranty without notice.

In that Horizon Hobby has no control over the final assembly or material used for the final assembly, no liability shall be assumed nor accepted for any damage of the final user-assembled product. By the act of using the product, the user accepts all resulting liability.

Once assembly of the model has been started, you must contact Horizon Hobby, Inc. directly regarding any warranty question that you have. Please do not contact your local hobby shop regarding warranty issues, even if that is where you purchased it. This will enable Horizon to better answer your questions and service you in the event that you may need any assistance.

If the buyer is not prepared to accept the liability associated with the use of this product, the buyer is advised to return this kit immediately in new and unused condition to the place of purchase.

Horizon Hobby
4105 Fieldstone Road
Champaign, Illinois 61822
(217) 355-9511
www.horizonhobby.com

Section 1: Aileron Servo Installation

Required Parts

- Top wing panels (left and right)
- Bottom wing panels (left and right)
- 24" Aileron Extensions (JRPA102) (4)
- 6" Aileron Extensions (JRPA095) (4)
- Servos w/mounting hardware (60 oz in minimum torque) (8)
- Y-Harness (JRPA133)
- 1" Servo Arms (HAN3574-JR or HAN3575-Futaba) (8)

Required Tools and Adhesives

- Hobby knife
- Drill
- Tap handle
- Thread or dental floss
- Drill Bit: 1/16"
- Tap: 8-32
- Phillips screwdriver
- Felt-tipped pen

Note: The ailerons require servos with a minimum of 120 oz in of torque. We installed JR 8411 digital servos for the ultimate in precision control.

MatchBox Option: To simplify the installation of the aileron servos, you may want to use the JR™ MatchBox™ servo matching/power system (JRPA900). Four MatchBoxes would be used in this application—one for each wing panel. The MatchBox allows easy adjustment of the servo's center and endpoints, making aileron setup a snap. You can also use a separate battery to run the Matchbox, reducing the load on the flight battery powering the receiver.

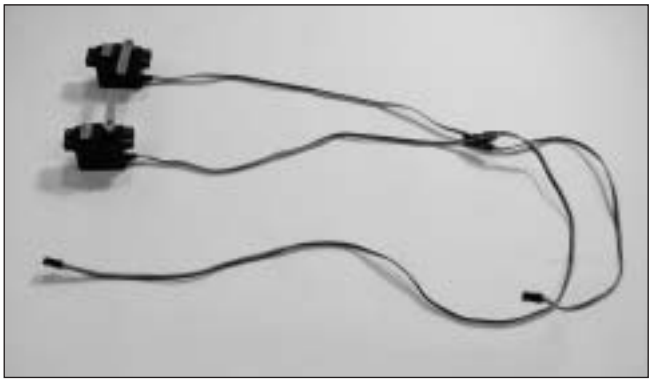
FAST FACTS: It is common to use two servos per aileron on many larger models. This setup requires some special attention to assure the servos do not fight each other. If this is not done correctly, battery consumption will be greatly increased, and in the case of a high torque digital servo, the servos may be damaged. When setting up the ailerons with two servos, there are some special steps that need to be taken.

Step 1

Select two sets of servos and Hangar 9® 1" arms that have the same neutral. All servos will have a slightly different neutral. If you are using Hangar 9 metal arms, they don't always orient the same, (i.e. the splines are not oriented the same relative to the arm). First choose one servo and arm, plug it into the aileron channel on your receiver through the Y-connection and set to EXACT NEUTRAL, (i.e. servo arm is perpendicular to the servo centerline). Next, start plugging in your other servos one by one and installing the arms until you find one that is as close as you can get to the EXACT SAME NEUTRAL as the other servo. Repeat this process to find a total of four sets of servos. A MatchBox comes in handy here, as the servos can be made to match, and the above steps can be skipped.

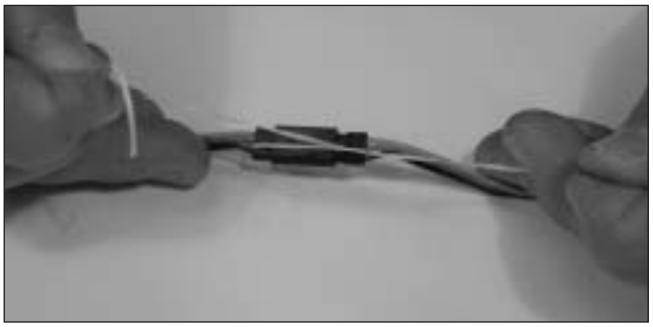
Step 2

Install the servo hardware (grommets and eyelets) included with the servos. Plug a 6" and 24" extension into each of the sets of matched aileron servos.



Step 3

Use string, dental floss or a commercially available device to secure the servo lead to the extension.



Section 1: Aileron Servo Installation

Note: It is always a good idea to secure the servo connector and servo extension together to prevent the wires from becoming unplugged inside the wing.

Step 4

Tie a weight to a piece of string. A wheel collar works great in this application. Lower the string into the wing from the root. Let the weight drop out through the opening for the servo.

Step 5

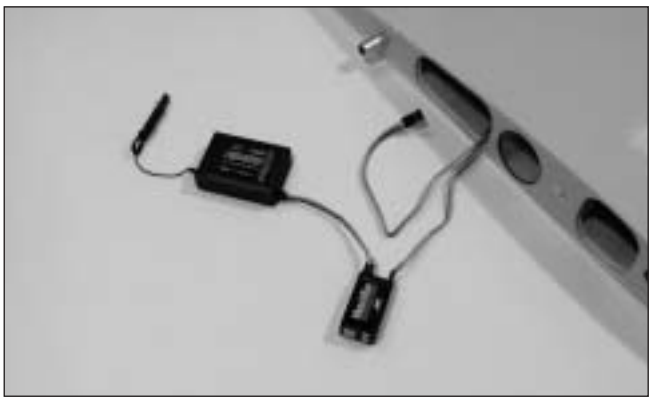
Insert the servo with the 24" extension towards the tip of the wing. Use the string to pull the servo lead through the wing. Position the servo so the output shaft is towards the trailing edge of the wing. Use a 1/16" drill bit to drill the locations for the servo screws.

Step 6

Secure the servo using the screws provided with the servo.

Step 7

Plug a JR™ MatchBox™ into the servos for each wing panel. The final installation of the servos and linkages will be covered in a later section.



Section 2: Temporary Hinging of the Ailerons

Required Parts

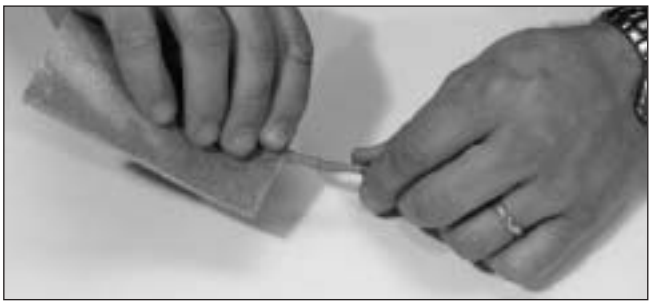
- Hinges (16)
- Bottom wing panel (2)
- Bottom aileron (2)
- Top wing panel (2)
- Top aileron (2)

Required Tools and Adhesives

- Coarse sandpaper

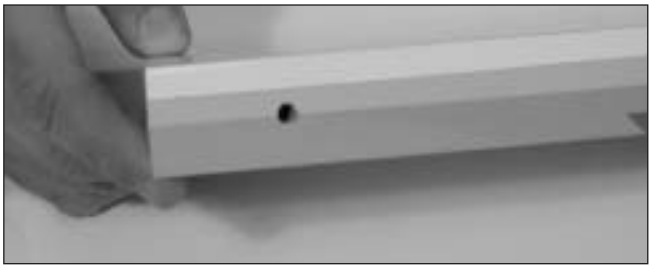
Step 1

Locate the hinges. Lightly sand each end of the hinge point using coarse sandpaper. This will improve the bond of the epoxy to the hinge.



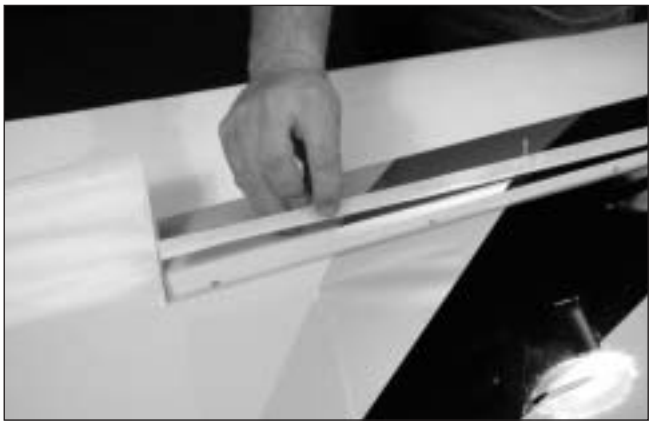
Step 2

Make sure the holes in the aileron and wing for the hinges are clear of covering. Use a hobby knife to remove the covering if necessary.



Step 3

Temporarily install all the hinges in the aileron. Check the fit of the hinges between the wing and aileron. Make sure the gap is as close as possible while making sure the throws listed in the back of the manual can still be achieved.



Note: Do not glue the hinges at this time. The ailerons must be removed to drill the locations for the control horns.

Section 3: Aileron Control Horn Installation

Required Parts

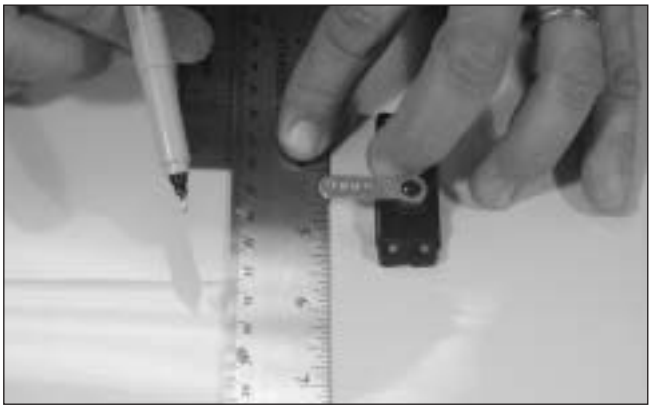
- Control horn screws (4)
- Control horn nuts (4)

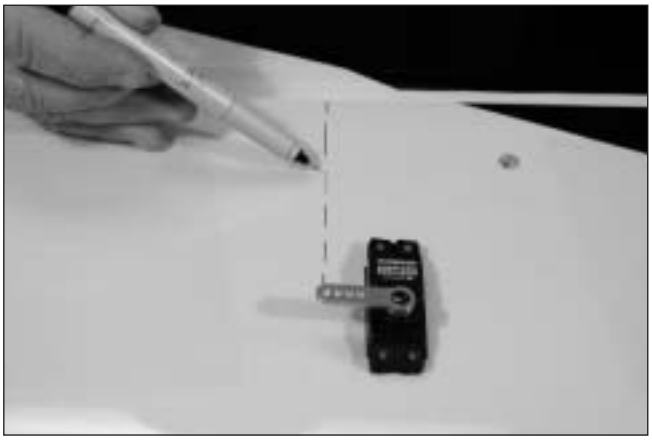
Required Tools and Adhesives

- Hobby knife
- Drill
- Tap handle
- Drill Bit: 5/32” and 5/16”
- Tap: 8-32
- Phillips screwdriver

Step 1

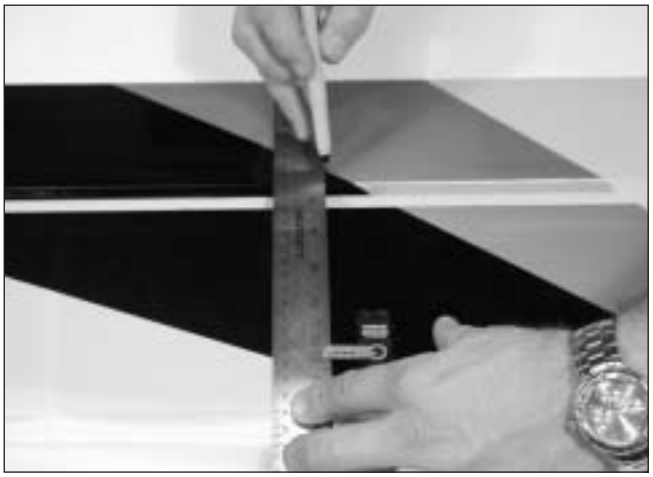
Draw a line perpendicular to the trailing edge. The line must align with the outer hole on the servo arm.

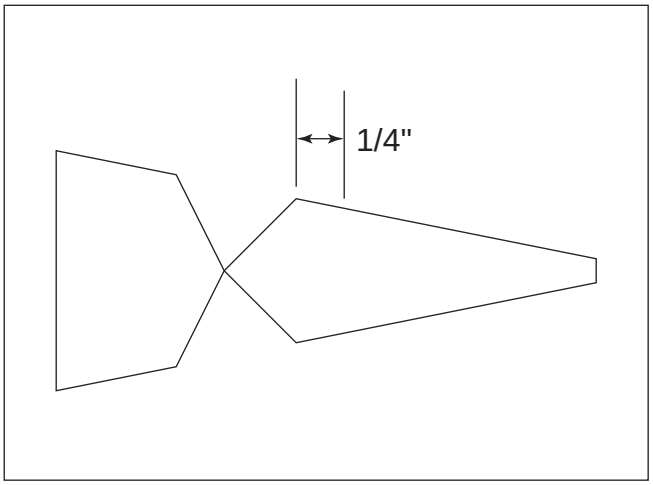




Step 2

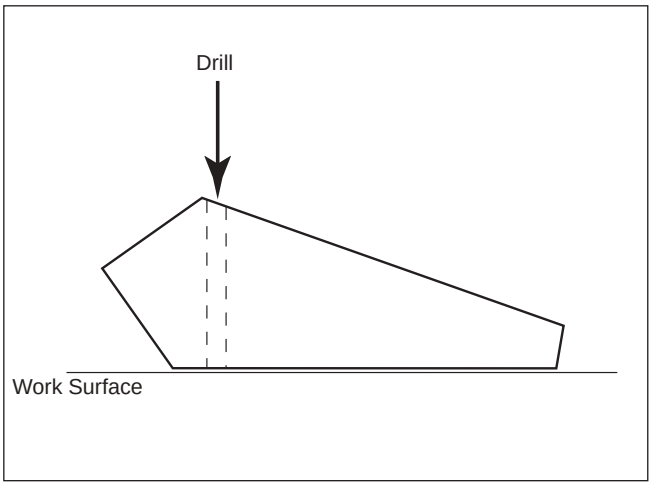
Mark the location for the aileron control horn. The horn is positioned as shown.





Step 3

Remove the aileron from the wing panel. Drill a 5/32" hole perpendicular to the work surface in the location marked for the aileron control horn. The top of the aileron will be resting flat on the work surface. This will angle the horn slightly forward and align the clevis with the hinge line when installed. It is highly recommended to use a drill press to drill this hole.



Step 4

Tap the hole for the screw using an 8-32 tap.

Step 5

Thread the screw into the hole from the top of the aileron. Trace around the head of the screw using a felt-tipped pen.

Section 3: Aileron Control Horn Installation

Step 6

Remove the screw, then use a hobby knife, counter sink bit, or 5/16” drill bit to taper the hole. This is done to counter-sink the head of the screw into the aileron.

Step 7

Once the aileron has been counter-sunk, thread the screw back into the aileron.

Step 8

Repeat Steps 1 through 7 for the remaining ailerons.

Section 4: Gluing the Aileron Hinges

Required Parts

- Hinges (16)
- Bottom wing panel (2)
- Bottom aileron (2)
- Top wing panel (2)
- Top aileron (2)

Required Tools and Adhesives

- 30-minute epoxy
- Syringe or toothpick
- Masking tape
- Denatured alcohol
- Coarse sandpaper
- Small brush
- Paper towel

FAST FACTS: Properly hinging the control surfaces on giant-scale models is vitally important! Poorly installed hinges affect the model's precision and control response and can also be dangerous. Each and every hinge needs to be securely bonded in place in both the flying surface and the control surface. The hinge pivot points need to be exactly parallel to each other and precisely located on the center of the hinge line. We regularly use Robart Super Hinge Points in all giant-scale aircraft. They are easy to install, very strong and offer smooth friction-free control. The Hangar 9® Ultimate control surfaces are predrilled to use Robart Super Hinge Points (ROB309).

Step 1

Mix 1 ounce of 30-minute epoxy. Using a glue syringe or toothpick, place a sufficient amount of 30-minute epoxy into the hinge pockets on the aileron. Install the hinge points until the hinge point center is flush with the leading edge of the aileron. Some epoxy should ooze out of the pocket as the hinge is installed. If not, remove the hinge and apply more epoxy. Wipe away excess epoxy with Denatured alcohol. Recheck that the center of the hinge point is flush and parallel with the leading edge. Position the hinges at 90 degrees and let the epoxy fully cure. The ailerons will be installed after the epoxy is fully cured.

Photo for Step 1

Photo for Step 1

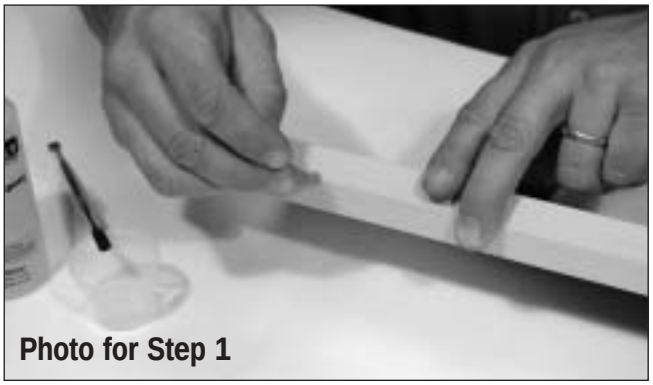


Photo for Step 1

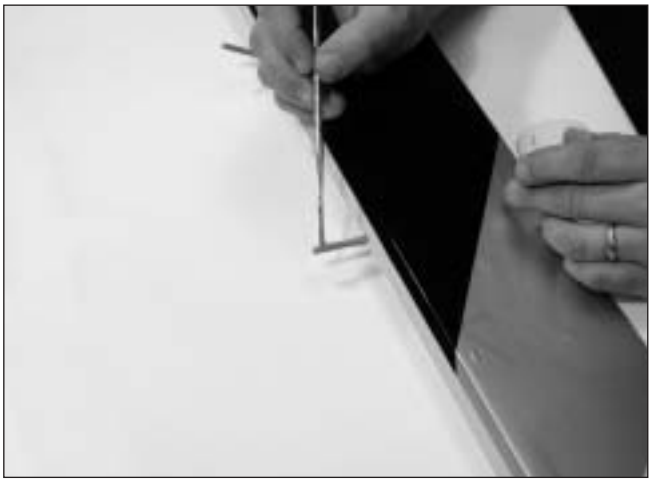
Photo for Step 1

Section 4: Gluing the Aileron Hinges

Note: Be sure that the hinge pivot pins are parallel and flush to the trailing edge. It's important to frequently mix a fresh batch of 30-minute epoxy in order to achieve good glue joint penetration. If you notice the epoxy becoming thicker, mix a new batch.

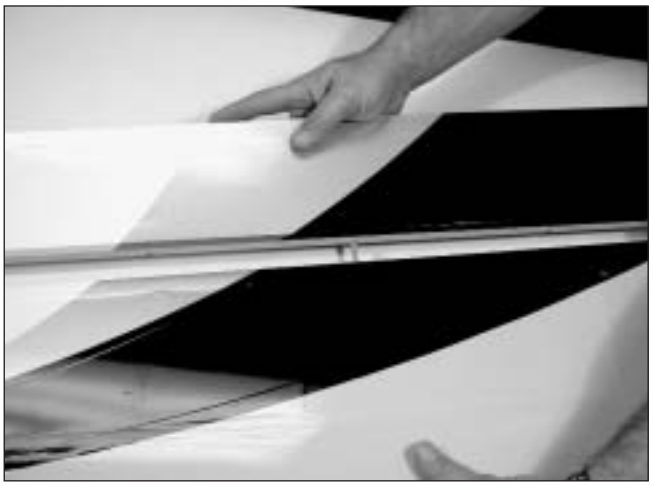
Step 2

Mix 1 ounce of 30-minute epoxy. Lightly coat each hinge using an epoxy brush or mixing stick. Use a syringe or toothpick to place a sufficient amount of epoxy in each hinge pocket in the wing. Place the hinges in the same positions to make the installation in the wing easier.



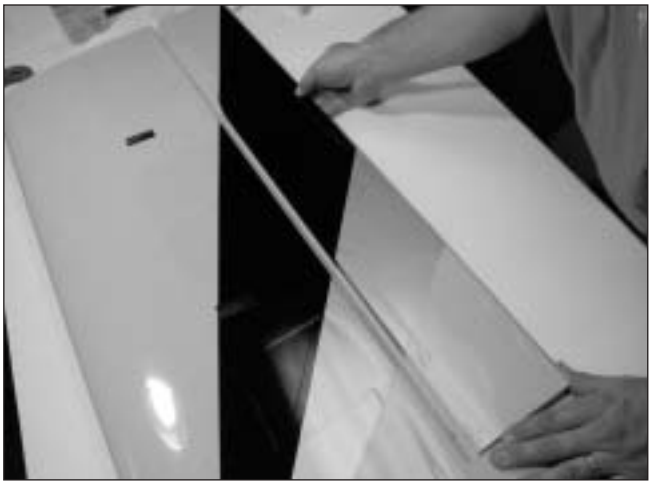
Step 3

Carefully slide the aileron onto the wing. Remove any excess epoxy using a paper towel and Denatured alcohol. Apply even pressure to avoid twisting the aileron and damaging the hinge pockets or hinges.



Step 4

Move the aileron up and down through its range of movement. Check to make sure the hinge gap is small as possible (1/32" average) yet still achieves proper throw.



Step 5

Use masking tape to hold the aileron in position while the epoxy cures.

Step 6

Repeat Steps 1 through 5 for the remaining ailerons.

Section 5: Aileron Linkage Installation

Required Parts

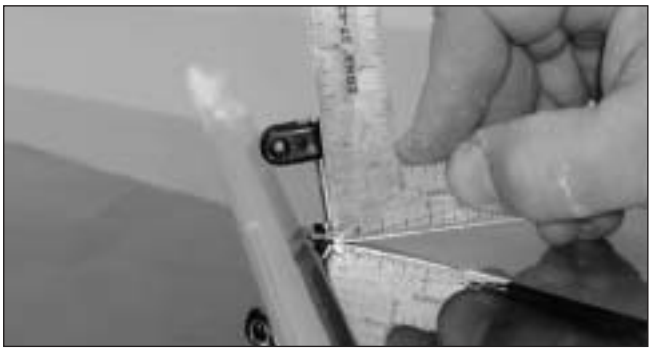
- Control horns (4)
- Wing assembly
- 4-40 x 3-1/2” Pro-Links (HAN3554) (8)
- 4-40 ball links (DLR87) (8)

Required Tools and Adhesives

- Phillips screwdriver
- Pro-Link Wrench (HAN3558)

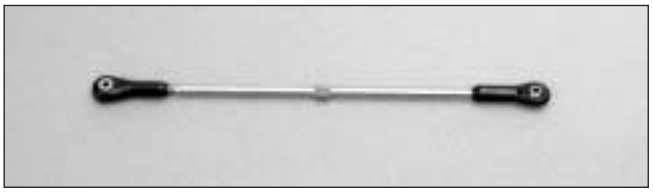
Step 1

Thread a clevis onto the inboard control horn screw until the bottom of the clevis is 1/2" from the base of the aileron.



Step 2

Install a 4-40 ball link five to six turns onto a 3 $^{1}/_{4}$" long 4-40 Pro-Link. Screw the opposite end of the linkage five to six turns into a clevis that will attach to the swivel control horn installed in the previous step.

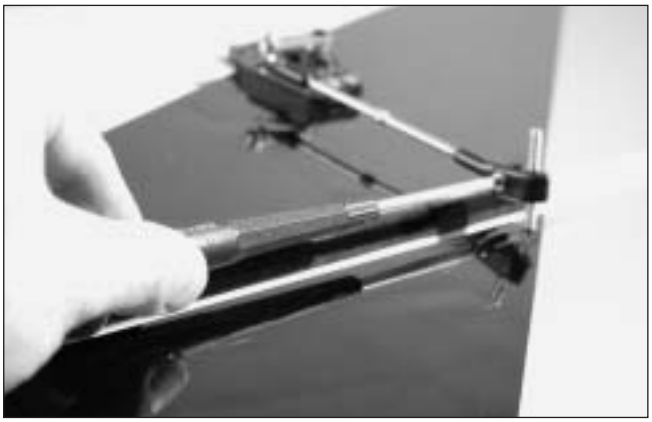


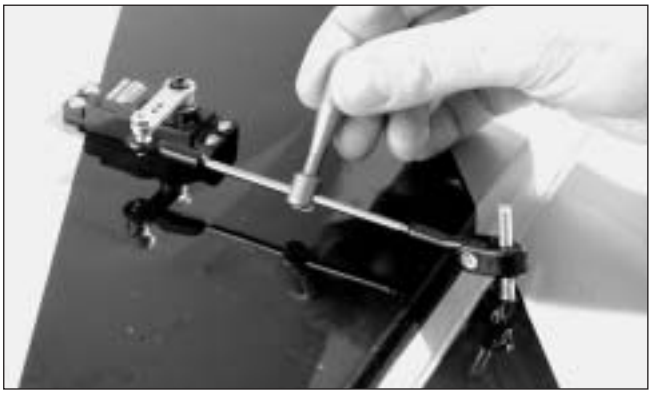
Note: Hangar 9® Titanium Pro-Links feature right-hand threads on one end and left-hand threads on the other. This allows for easy, accurate adjustment without disconnecting the linkages. Consistently putting the right-hand threads toward the servo arms on all servos will prevent you from getting confused as to which way to turn the Pro-Link to lengthen or shorten the linkage. Hangar 9 also offers a Pro-Link Wrench (HAN3558) to make adjustments easier.

Section 5: Aileron Linkage Installation

Step 3

Attach the linkage to the swivel horn on the inboard servo only with the bolt supplied. Adjust the linkage length until the hole in the ball link aligns with the outer hole in the servo arm when the aileron is neutral and the servo arm is centered.





Step 4

Repeat Step 3 for the second linkage, but do not connect it to the servo arm.

Step 5

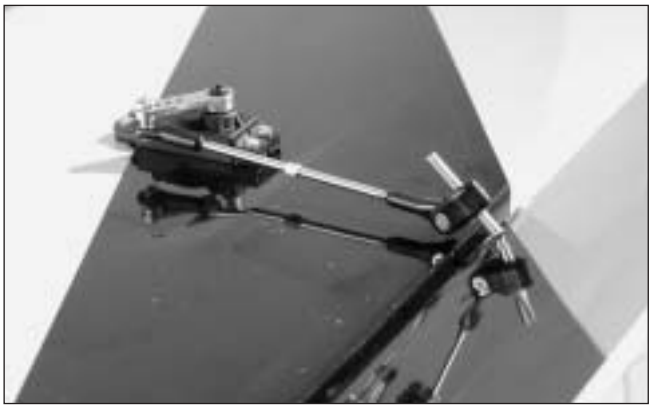
Temporarily plug the servos into the receiver and set the programming to get the aileron functioning correctly. Center the control surface with the trailing edge of the wing.

Step 6

Install the clevis on the outboard control horn. Thread on the clevis until the clevis is the same distance from the aileron hinge line as the inboard clevis.

Step 7

Deflect the ailerons stick to full right and hold it there. The easiest way is to have your transmitter set to PCM: hold and then turn off the transmitter. Hold the clevis on the outboard servo up to the horn and note how the holes align. Turn the transmitter on and hold full left aileron and again note how the holes align. The holes have to line up nearly perfectly. If they don't line up perfectly, adjust the horn length (distance out from the aileron) in or out a turn and recheck. Repeat this process until it is nearly perfect at full deflection in both stick directions and at neutral.



Step 8

Attach the swivel clevis to the horn with the supplied screw.

Step 9

Once both linkages have been adjusted, secure the servo arm to the servo using the screw provided with the servo.

Step 10

Repeat Steps 1 through 9 for all servos.

Section 6: Hinging the Elevators

Required Parts

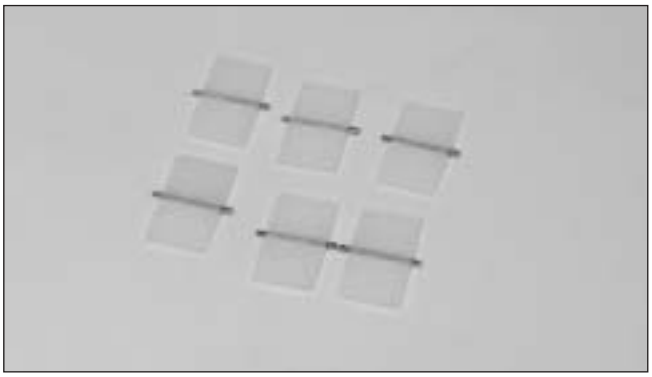
- Hinges (6)
- Elevator (2)
- Stabilizer

Required Tools and Adhesives

- 30-minute epoxy
- Small brush
- Felt-tipped pen
- Razor saw
- Denatured alcohol
- Hobby knife or hinging tool
- Drill
- Toothpicks or small dowel
- Masking tape
- Ruler
- Paper towel
- Drill Bit: 1/16"

Step 1

Locate the hinges for the elevator.



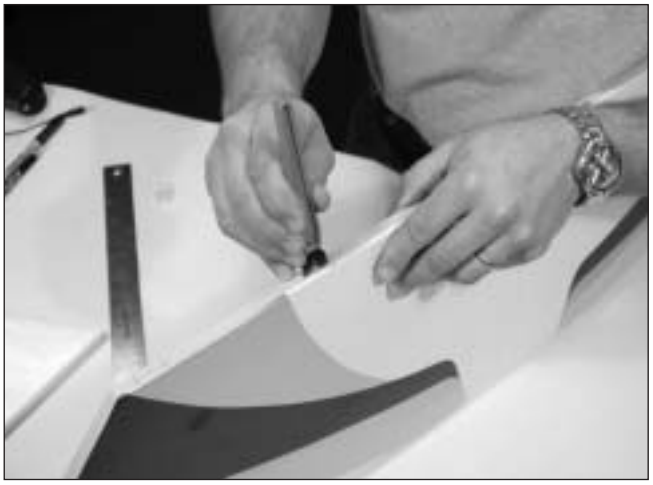
Step 2

Position the inner hinge near the fuselage so it is centered 1 $^{1}/_{2}$" away from the fuselage. The outer hinge near the tip of the elevator is centered 1" in from the end of the stabilizer. Use a ruler to determine the location of the center hinge. Measure the location on both the stabilizer and elevator.

Photo for Step 2

Step 3

Use a hobby knife or hinging tool to cut the slots for the hinges in the stabilizer.



Section 6: Hinging the Elevators

Step 4

Install the hinges in the stabilizer.

Step 5

Slide the elevators into position against the stabilizer. Use a felt-tipped pen to accurately transfer the location of the hinges onto the elevators.

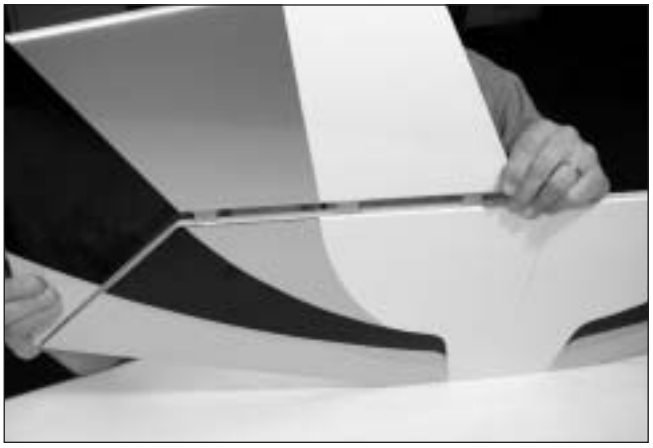
Step 6

Mix 1/2 ounce of 30-minute epoxy. Apply the epoxy to one side of a hinge. Slide the hinge into the elevator. Clean up any excess epoxy from the hinge using denatured alcohol and a paper towel. Allow the epoxy to fully cure before continuing to the next step.

Photo for Step 6

Step 7

Check the fit between the stabilizer and elevator. Adjust the slots in the stabilizer if necessary. Once the fit is satisfactory, mix 1/2 ounce of 30-minute epoxy and join the elevators and stabilizer.



Step 8

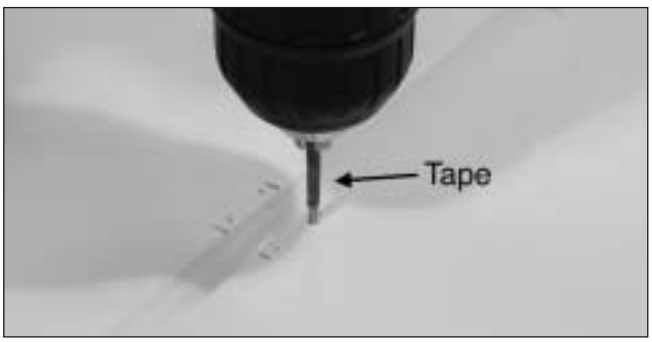
Clean up any excess epoxy using a paper towel and denatured alcohol.

Step 9

Mark locations at the hinges for pinning the hinge. Each mark should be 1/8" inside of the edge of the hinge. Perform this step for all six hinges on both the elevators and stabilizer.

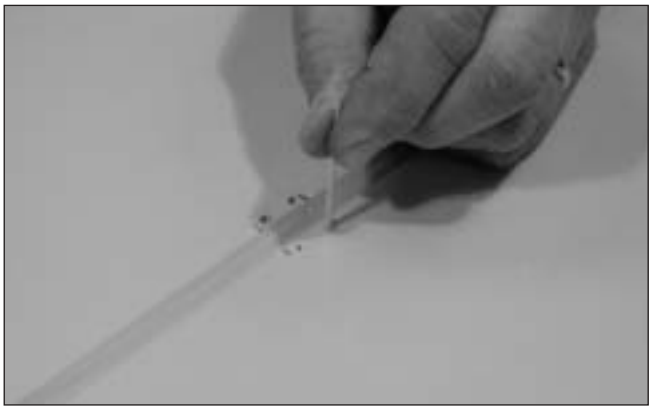
Step 10

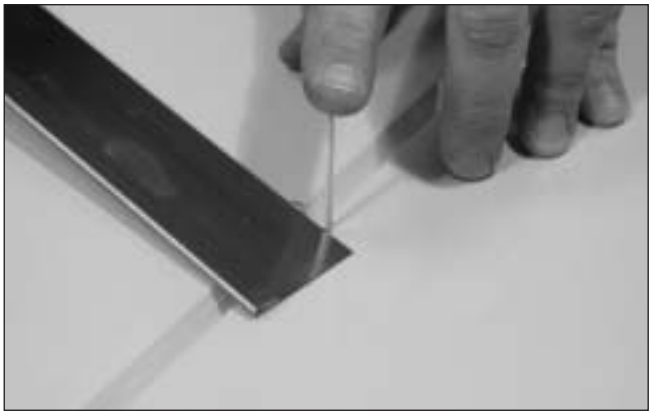
Drill the locations for the pins using a 1/16" drill bit. Drill from the bottom of the stabilizer and elevator through the hinge but not through the top of the elevator or stabilizer. Wrap a piece of tape around the drill bit as a depth gauge to prevent drilling through.



Step 11

Cut the tapered portion off the tip of a round toothpick. Place the toothpick (or small dowel) into the holes drilled. Use a razor saw to trim the excess flush with the elevator and stabilizer. Apply medium CA to secure the toothpicks to the elevators and stabilizer





Section 7: Hinging the Rudder

Required Parts

- Hinges (5)
- Fin
- Rudder

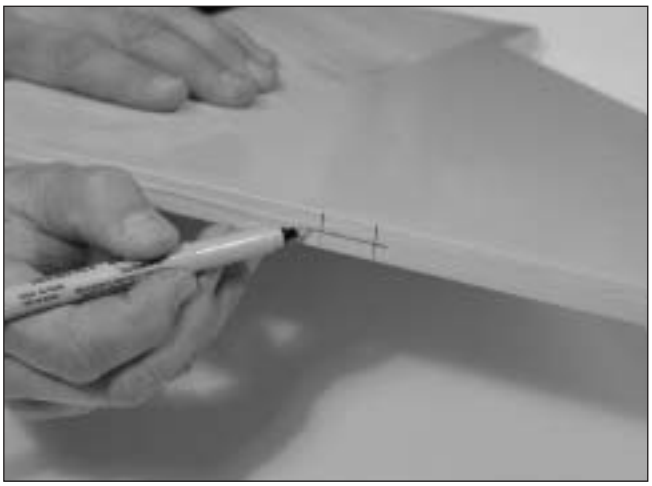
Required Tools and Adhesives

- 30-minute epoxy
- Small brush
- Felt-tipped pen
- Razor saw
- Denatured alcohol
- Hobby knife or hinging tool
- Drill
- Toothpicks or small dowel
- Masking tape
- Ruler
- Paper towel
- Drill Bit: 1/16"

Step 1

Locate the hinges for the fin. Use a ruler to locate the hinges evenly along the length of the fin. Use a hinging tool or hobby knife to cut the slots for the hinges in the fin.

> **Note**: Make sure the lower fin post is included when positioning the hinges.



Step 2

Slide the fin up against the rudder. Mark the locations of the hinges on the rudder using a felt-tipped pen. Cut the slots for the hinges in the rudder using a hinging tool or hobby knife.

> **Note**: Make sure to avoid placing the lower hinge in the same location as the rudder horn dowel.

Photo for Step 2

Step 3

Trim the rudder slightly at the hinge locations. This provides room for the center of the hinge to achieve the maximum amount of rudder throw and to provide the smallest gap between the rudder and fin.

Step 4

Scuff the hinges using sandpaper. Mix 1/2 ounce of 30-minute epoxy and glue the hinges into the rudder. Clean up any excess epoxy using a paper towel and Denatured alcohol. Allow the epoxy to fully cure before continuing to the next step.

Step 5

Test fit the rudder to the fin. Make any corrections to the hinge slots in the fin so the top of the rudder aligns with the top of the fin. Mix 1/2 ounce of 30-minute epoxy and apply it to the hinges. Slide the hinges into the fin. Use tape to hold the rudder and fin together until the epoxy fully cures.

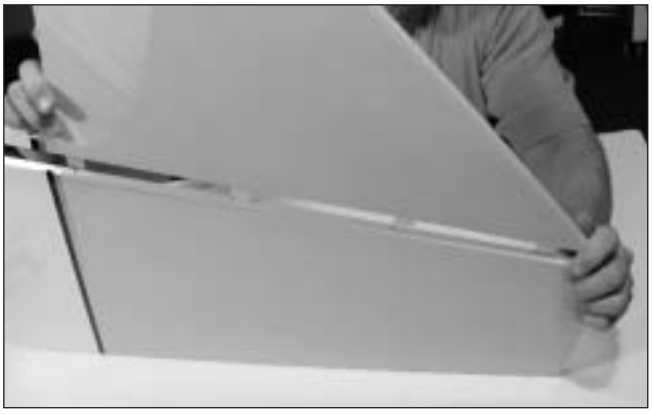


Photo for Step 5

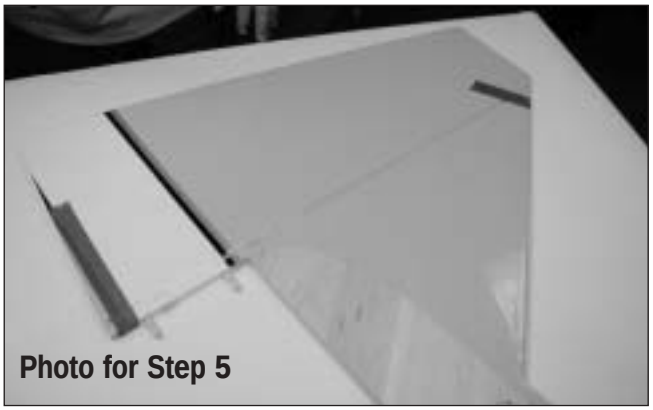


Photo for Step 5

Section 8: Sealing the Hinge Gap

Required Parts

- Covering (not included)

Required Tools and Adhesives

- Covering iron
- Hobby knife
- Trim tool
- Scissors

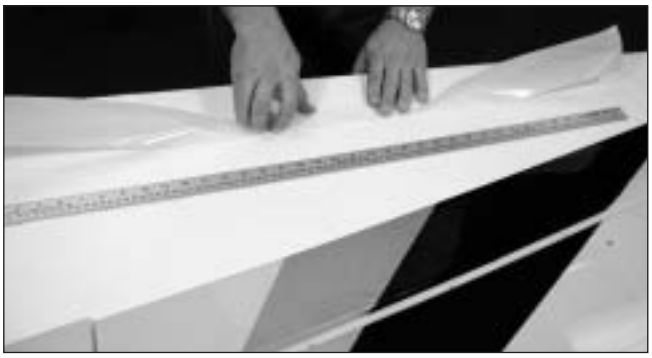
FAST FACTS: Sealing Hinge Gaps.
Sealing the aileron and elevator hinge lines has several advantages. A sealed hinge line gives a greater control response for a given control deflection. It also offers more precise, consistent control responses and makes trimming easier, and can even prevent flutter.

Step 1

Locate the covering that has been included to seal the hinge gaps for the ailerons and elevator.

Step 2

Fold the covering down the center with the adhesive side to the outside, making a sharp crease in the fold.



Step 3

Position the covering into the hinge gap. Use a covering iron and trim tool to iron the covering down into the hinge gap of the ailerons.

Hint: Iron the covering from the bottom of the wing. This way it can't be seen once the airplane is fully assembled.

Step 4

Repeat Steps 1 through 3 for all four ailerons.

Step 5

Repeat Steps 1 through 3 for both elevators.

Section 9: Elevator Control Horn Installation

Required Parts

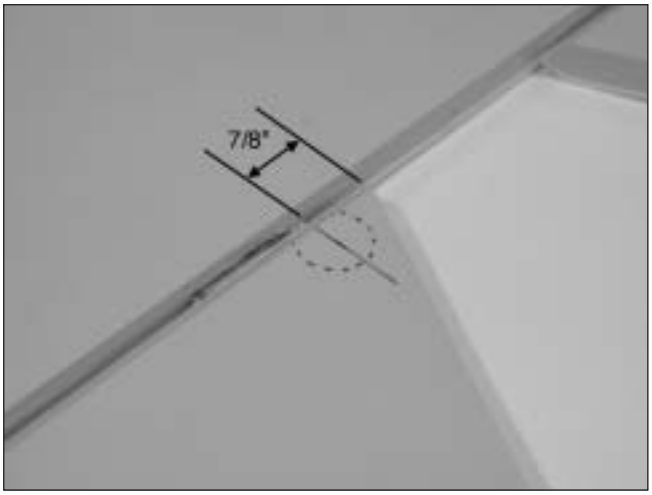
- Control horn screws (2)
- Control horn nuts (2)

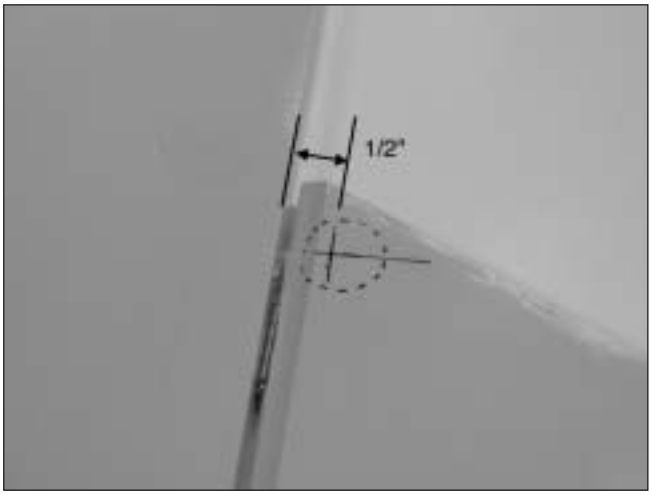
Required Tools and Adhesives

- Hobby knife
- Drill
- Tap handle
- Felt-tipped pen
- Drill Bit: 5/32" and 5/16"
- Tap: 8-32
- Phillips screwdriver
- Threadlocking compound

Step 1

Measure in 7/8" from the inside edge of the elevator and 1/2" back from the trailing edge of the stabilizer and mark the location for the elevator control horn.

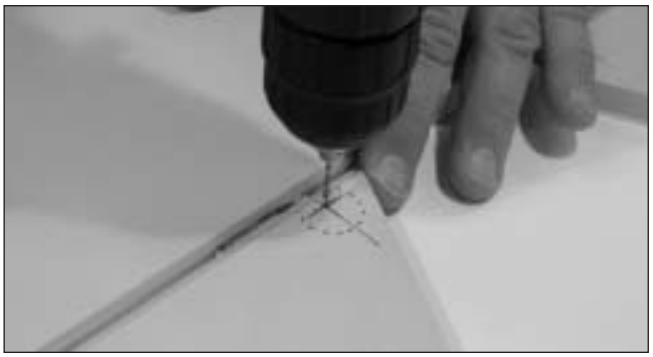




Step 2

Use a 5/32" drill bit to drill through the elevators. Again, use a drill press for the best results.

> **Important**: Make sure to drill perpendicular to the elevator.



Step 3

Tap the hole drilled in the previous step using an 8-32 tap.

Step 4

Use a counter sink bit or 5/16" drill bit to taper the hole. This is done to counter-sink the head of the screw into the elevators.

Section 9: Elevator Control Horn Installation

Step 5

Install the control horn screw into the elevator.

Step 6

Thread a control horn nut down onto the horn and against the elevator. Use a drop of threadlocking compound to keep the nut from vibrating loose during flight.

Section 10: Rudder Control Horn Installation

Required Parts

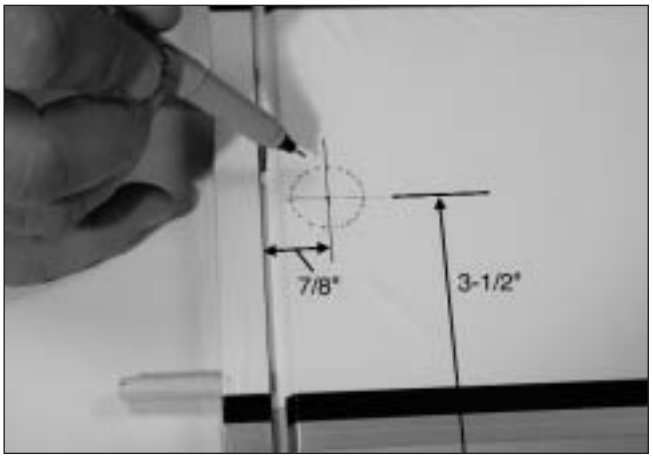
- Control horn standoff nuts (2)

Required Tools and Adhesives

- Hobby knife
- Drill
- Tap handle
- Threadlocking compound
- Drill Bit: 5/32"
- Tap: 8-32
- Felt-tipped pen

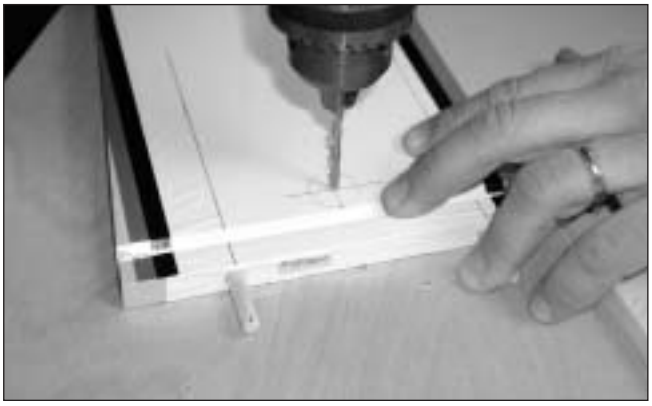
Step 1

Measure up 3 $^{1}/_{2}$" from the bottom edge of the rudder and 7/8" back from the trailing edge of the fin and mark the location for the rudder control horn.



Step 2

Use a 5/32" drill bit to drill through the rudder. A drill press will ensure the hole is perpendicular to the rudder.



Step 3

Tap the hole drilled in the previous step using an 8-32 tap.

Step 4

Cut a length of 8-32 threaded rod to 5". Thread the rod into the rudder until it is centered in the rudder.

Step 5

Thread the control horn standoff nuts onto the threaded rods. Use a drop of threadlocking compound to prevent the nuts from coming loose in flight.

Step 6

Bend the threaded rod forward 10 degrees. This is done to align the control horns with the rudder hinge line.

Section 11: Mounting the Horizontal Stabilizer

Required Parts

- Fuselage
- 6-32 blind nuts (4)
- 6-32 x 1" socket head bolts (4)
- Horizontal stabilizer assembly
- #6 washer (4)

Required Tools and Adhesives

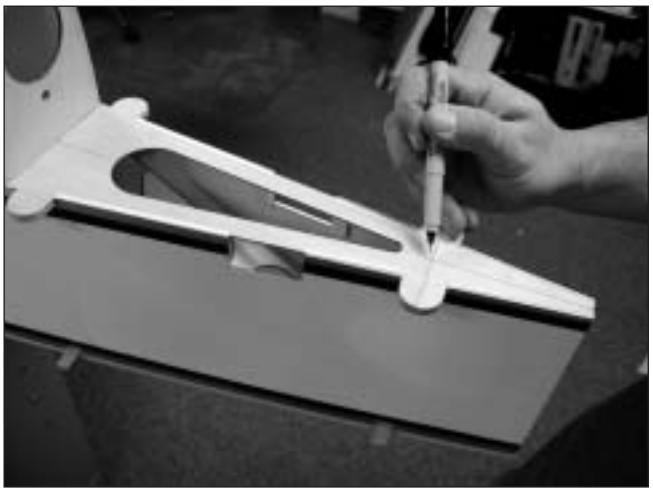
- Thick CA
- Ruler
- Drill Bit: 9/64", 11/64"
- Drill
- Masking tape
- Tape measure
- Pliers
- Hobby knife
- Square
- Felt-tipped pen
- Threadlocking compound

Step 1

Carefully measure and mark a centerline on the top of the stabilizer. Do not use the trim as a guide, as it may be slightly off-center.

Step 2

Measure and mark a centerline on the stabilizer base on the fuselage.



Step 3

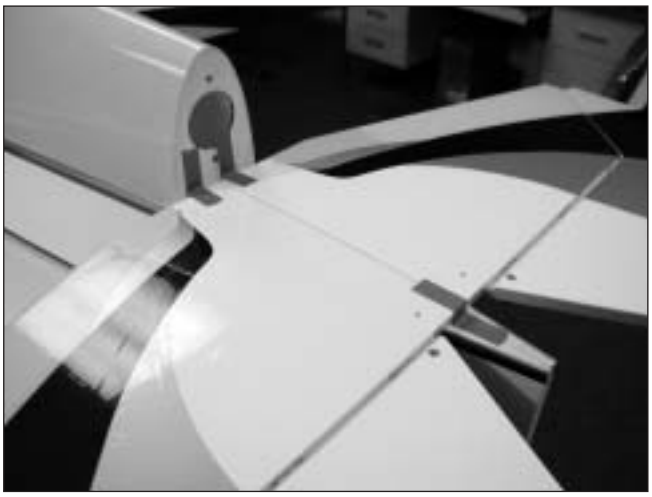
Use a square to extend the centerline on the stabilizer base onto the rear of the fuselage as shown.

Step 4

Install the bottom wing. Make sure the wing is pressed fully against the fuselage.

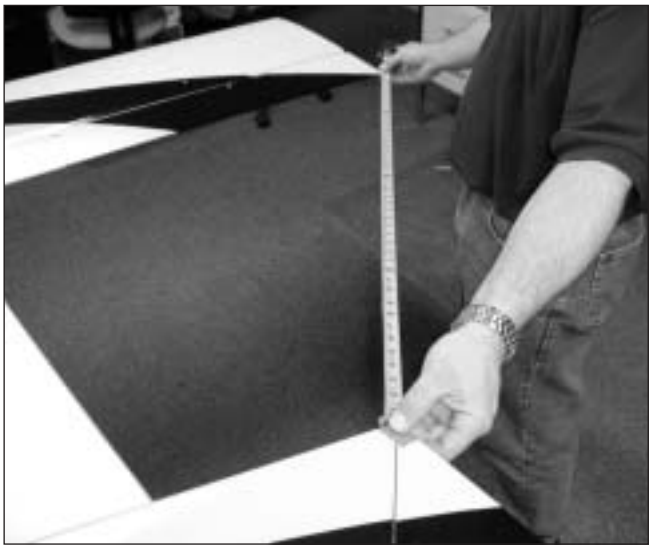
Step 5

Position the stabilizer on the stabilizer base. Use the centerline on the base and stab to aid in positioning. Use tape to hold the stab in position for the following step.



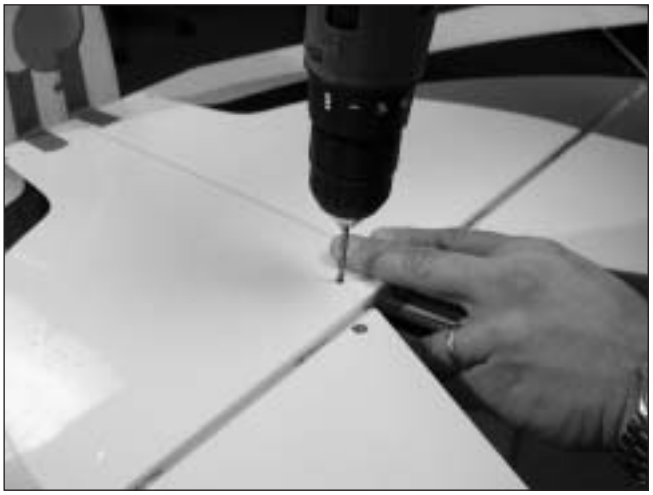
Step 6

Measure from the tip of the stab on right to the right wing tip and record the distance. Repeat this for the left side of the plane and compare the two measurements. If these measurements are different, adjust the stabilizer position until they are identical.



Step 7

Locate the four mounting holes in the stabilizer and remove the covering using a hobby knife. Carefully drill through the holes and through the stabilizer mounting flanges of the fuselage using a 9/64" drill bit.



Section 11: Mounting the Horizontal Stabilizer

Step 8

Remove the stabilizer and re-drill the holes in the stabilizer mounting flanges using an 11/64" drill bit. Place a piece of plywood under the flange to prevent the wood from splintering.

Step 9

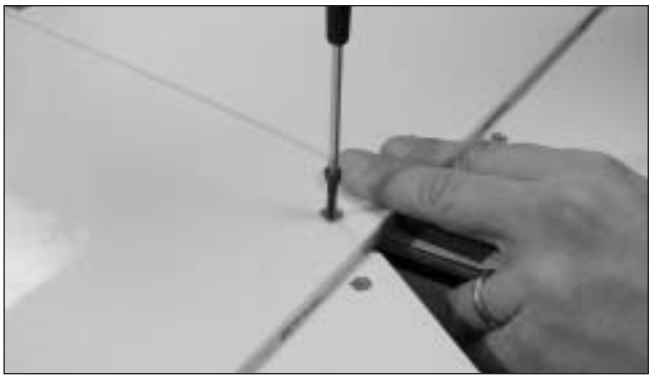
Use pliers to install four 6-32 blind nuts into the bottom of the stabilizer mounting flanges. Use a piece of plywood on the top side of the flange to prevent crushing the wood.

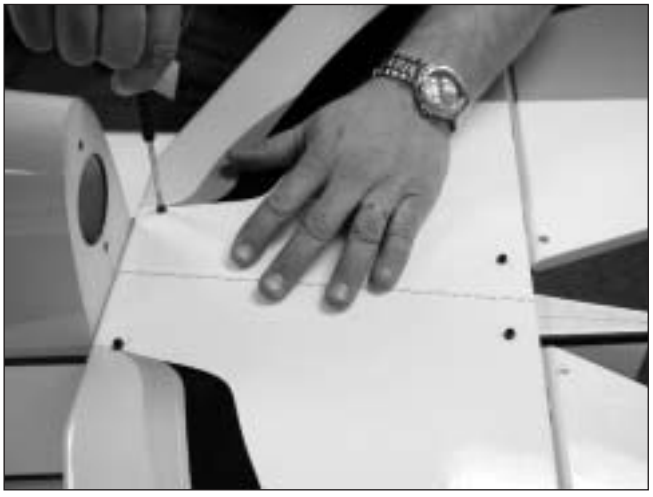
Step 10

Apply a few drops of thick CA to each blind nut. Use accelerator to cure the CA. Be careful not to get CA into the threads.

Step 11

Secure the stabilizer to the fuselage using four 6-32 x 1" socket head bolts and four #6 washer. Do not over-tighten the screw as this could damage the underlying wood and weaken the structure.





Section 12: Mounting the Vertical Stabilizer

Required Parts

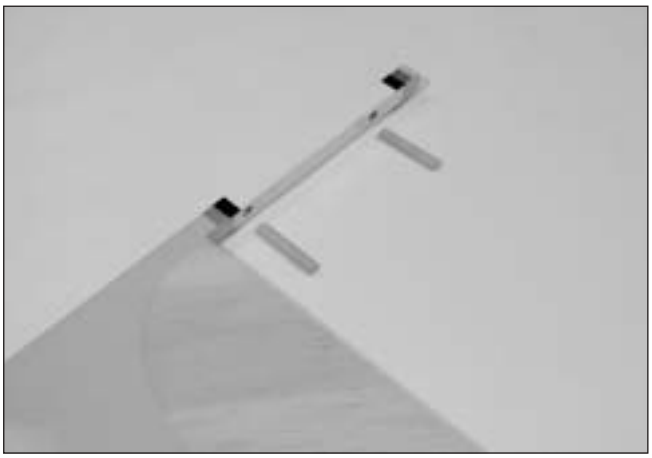
- Vertical stabilizer assembly
- Fuselage
- #2 x 1/2" sheet metal screws (2)
- 1/4" x 1 $^1/_2$" dowels (4)
- Fin fairing

Required Tools and Adhesives

- Drill Bit: 1/16"
- 30-minute epoxy
- Denatured alcohol
- Felt-tipped pen
- Drill
- Paper Towels
- Ruler

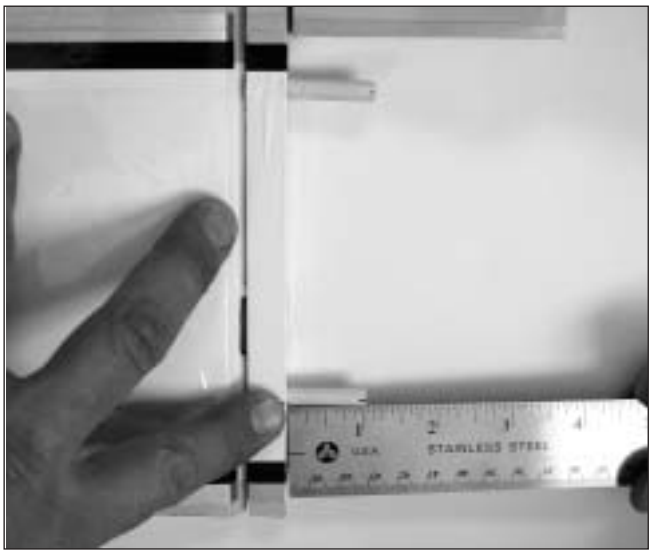
Step 1

Locate the 1/4" x 1 $^1/_2$" dowels. Test fit the dowels into the vertical stabilizer. The dowels should be flush with the back side of the vertical stabilizer and not interfere with the movement of the rudder.



Step 2

Measure the distance the dowels extend out of the fin. This distance should measure 1".



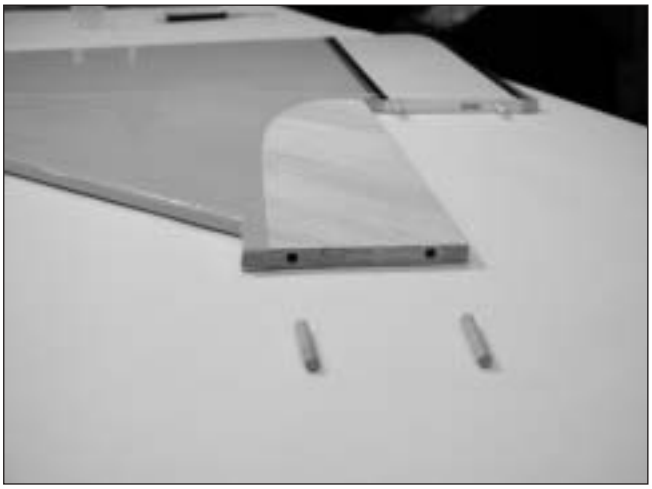
Step 3

Mix 1/2 ounce of 30-minute epoxy and apply it to the end of the dowel. Insert the dowel into the fin. Remove any excess epoxy using denatured alcohol and a paper towel. Install both dowels at this time.

Section 12: Mounting the Vertical Stabilizer

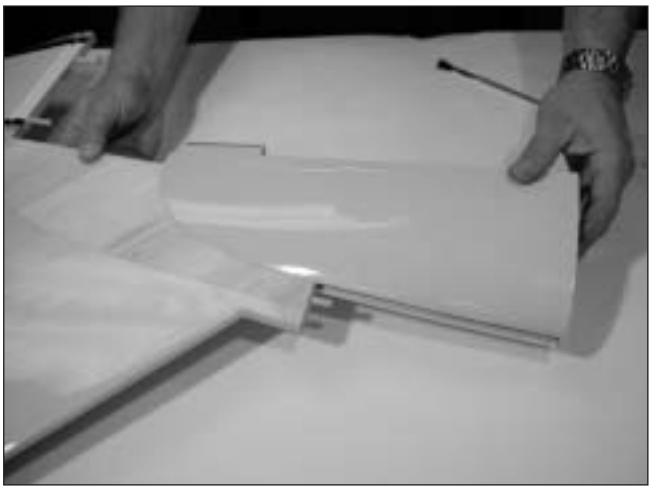
Step 4

Locate the two remaining dowels and test fit them into the fin as shown.



Step 5

Locate the fin fairing and position it on the fin.



Step 6

With the fin fairing installed, position the dowels so they protrude 3/4" from the fin fairing. Mark the dowels at the edge of the fairing using a felt-tipped pen.

Step 7

Use a felt-tipped pen to trace the outline of the fin fairing onto the fin. Remove the dowels and fin fairing. Use a sharp hobby knife to remove the covering from the fin 1/16" inside the line drawn.

> **Note**: Use extreme care not to cut into the underlying wood. Doing so could weaken the structure and failure in flight may occur.

Step 8

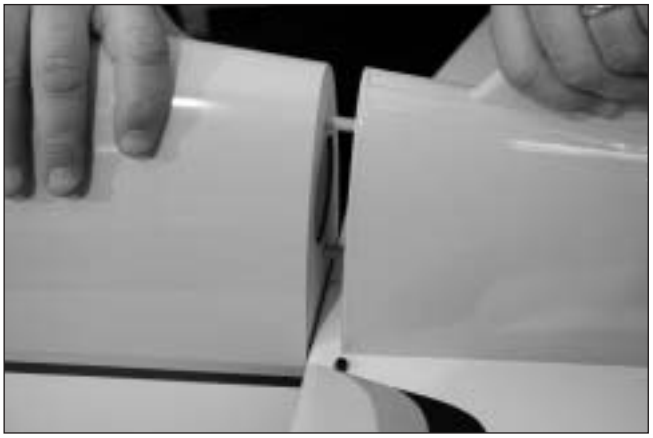
Mix 1/2 ounce of 30-minute epoxy and apply it to the end of the dowels. Install the dowels into the fin, and position them so the mark made in the last step is 1/8" from the edge of the fin. Allow the epoxy to fully cure before proceeding to the next step.

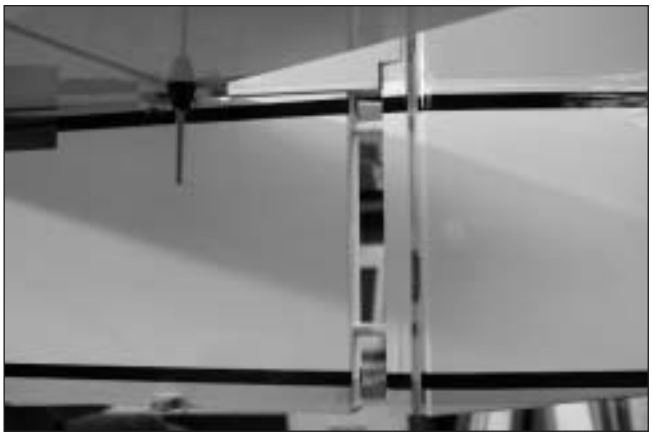
Step 9

Mix 1 ounce of 30-minute epoxy and lightly apply the epoxy to the inside edge of the fairing and the front edge of the fin. Slide the fairing into position, and use denatured alcohol and a paper towel to remove any excess epoxy. Allow the epoxy to fully cure before continuing to the next step.

Step 10

Test fit the fin onto the fuselage. Make adjustments to the holes in the fuselage to allow the fin to slide fully into position.





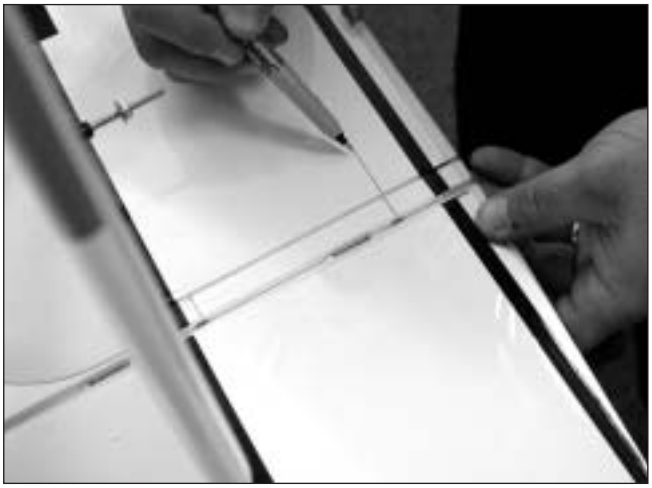
Step 11

Remove the fin and draw a line centered on each of the dowels.

Section 12: Mounting the Vertical Stabilizer

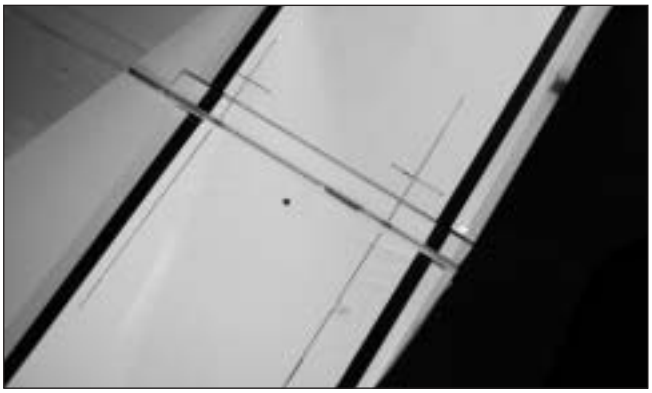
Step 12

Slide the fin back onto the fuselage. Align the ruler on the lines drawn on the rudder. Extend the two lines onto the fuselage.



Step 13

Measure and mark a vertical line 1" in front of the rudder hinge line.

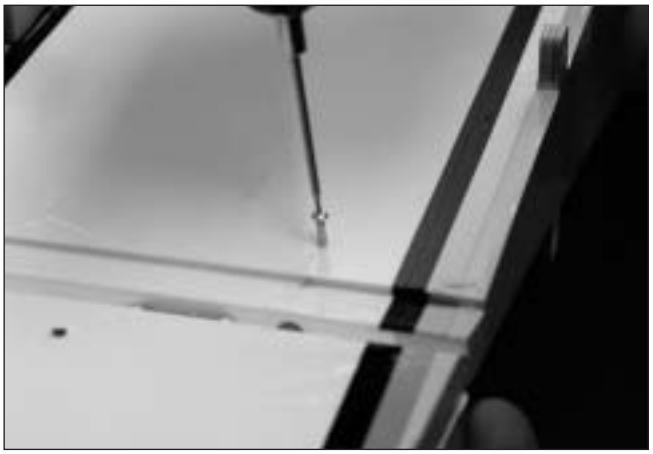


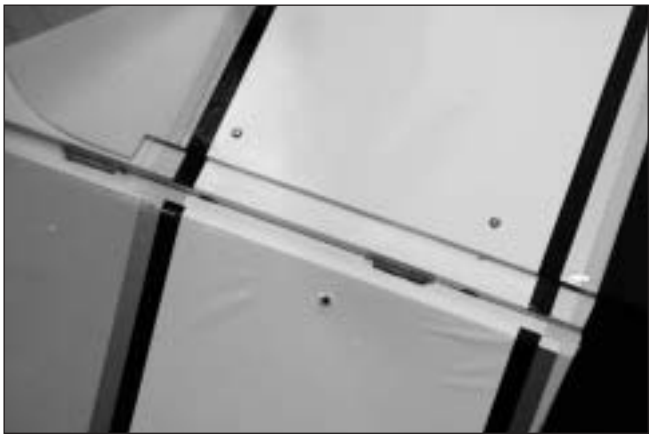
Step 14

Drill two 1/16" holes at the locations marked in the previous step. These holes do not need to extend through the fuselage.

Step 15

Secure the fin using two #2 x 1/2" sheet metal screws.





Section 13: Elevator Servo Installation

Required Parts

- Fuselage assembly
- 4-40 x 3 1/2" Pro-Links (HAN3554) (2)
- 4-40 ball links (DLR87) (8)

Required Tools and Adhesives

- Phillips screwdriver
- Pro-Link™ Wrench (HAN3558)

Step 1

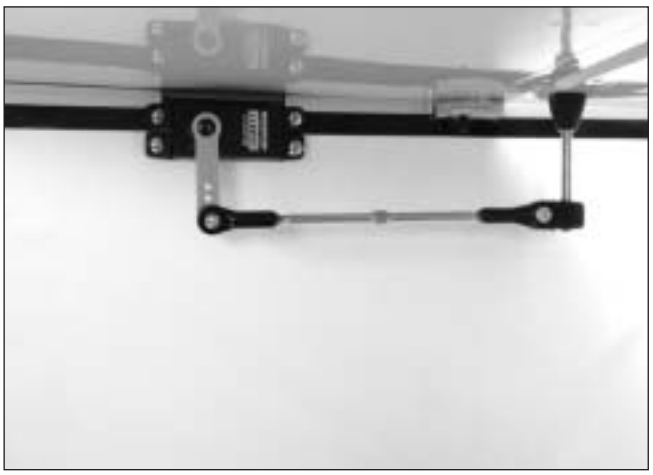
Install a 4-40 ball link five to six turns onto a 3 1/2" long 4-40 Pro-Link. Screw the opposite end of the linkage five to six turns into the clevis that is to attach to the swivel control horn that was installed in the previous step.

Step 2

Install the servo using the hardware provided with the servo. Position the output shaft of the servo towards the front of the fuselage.

Step 3

Install the linkage as shown. The bottom of the clevis will be positioned 1 1/2" from the elevator to provide the recommended amount of control throw.



Step 4

Repeat Steps 1 through 3 for the remaining elevator servo.

Section 14: Rudder Servo Installation

Required Parts

- Fuselage assembly
- Pull-pull cable
- Cable crimps (4)
- 4-40 nuts (4)
- Clevis (2)
- 4-40 rigging couplers (4)
- 4-40 Ball Links (DLR87) (8)
- 4-40 x 1 $^1/_2$" Pro-Links (HAN3550) (8)
- 4-40 Double Ball Link Connectors (HAN3691) (6)

Required Tools and Adhesives

- Phillips screwdriver
- Wrench
- Pro-Link™ Wrench (HAN3558)

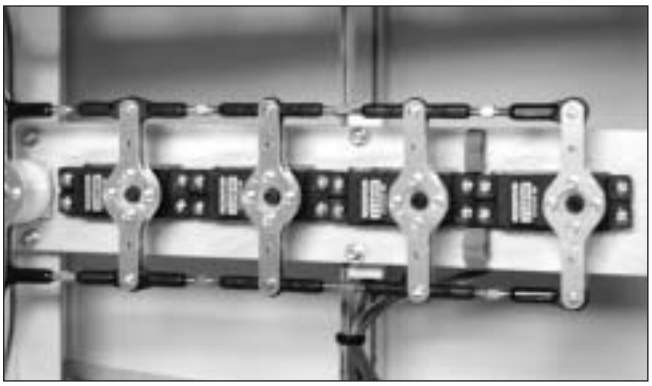
Note: There are many rudder servo linkage systems currently available. The servo arms and bellcrank shown in this section are available from Sure-Link (http://www.sure-link.com)

Step 1

Install the servos into the tray using the hardware provided with the servos. Make sure to install the grommets to protect the servos from vibrations.

Step 2

Install the linkages between the servos. Start at the front servo and work you way back, adjusting each linkage separately. Use care when adjusting the linkages as binding will quickly increase the load on the servos, which will draw more amperage from the battery. It will also cause premature failure of the servos. A JR™ MatchBox™ will make the task of adjusting and synchronizing the servos much easier.



Step 3

Mount the servo tray into the fuselage. Make sure it is secure, and will not move during the operation of the rudder.

Step 4

Locate the openings in the rear of the fuselage for the rudder cables. Carefully remove the covering to expose the openings.

Step 5

Feed the cable to the rudder servos from the openings.

Step 6

Install the ball ends, crimps, and couplers on both the rudder end and servo end of the cable. To achieve proper geometry the cables must criss-cross in the fuselage. Attach and adjust the cables, removing the slack. It is highly suggested to use a crimping tool to install the crimps.

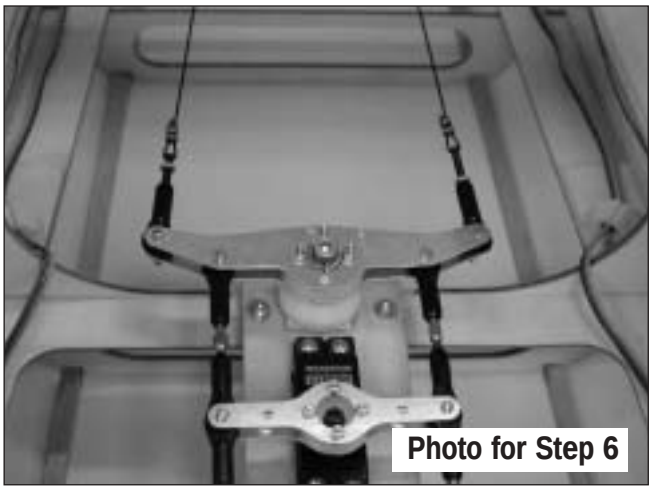


Photo for Step 6

Section 15: Tail Wire Bracing Installation

Required Parts

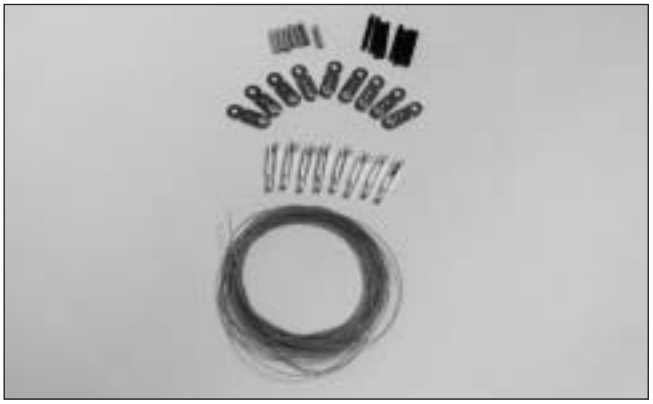
- Fuselage assembly
- Tail rigging set

Required Tools and Adhesives

- Hobby knife
- Drill Bit: 1/16"
- 6-minute epoxy
- Denatured alcohol
- Wrench
- Drill
- Medium CA

Step 1

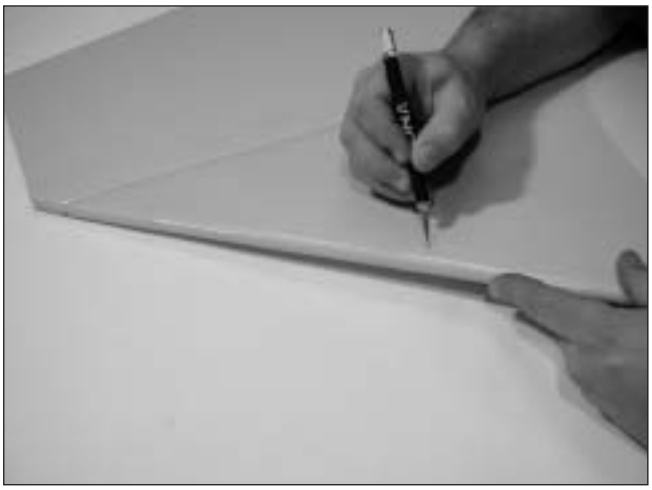
Locate the parts to install the tail rigging.



Section 15: Tail Wire Bracing Installation

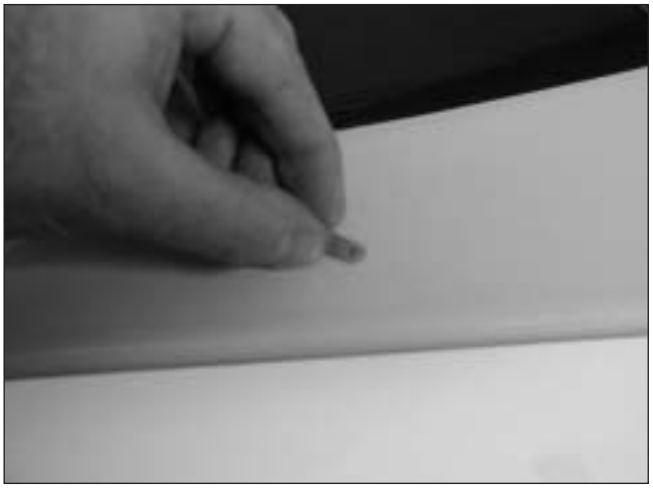
Step 2

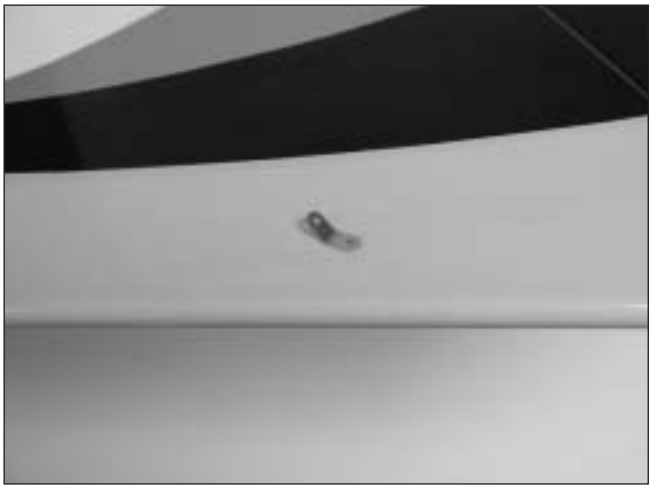
Locate the holes in the stabilizer and fin for the rigging attachments. There will be two holes in the fin, and two holes in the left and right sides of the stabilizer. Remove the covering to expose the holes using a hobby knife.



Step 3

Position the rigging attachments on the fin and stabilizer. It will be necessary to add a slight bend to the attachments as shown.



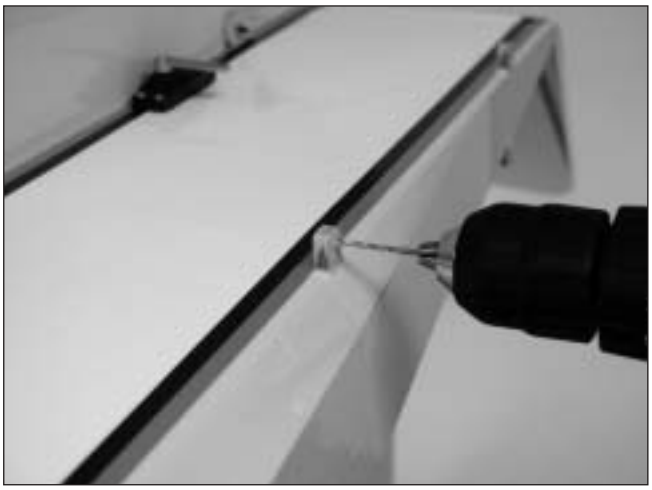


Step 4

Secure the rigging attachments using 4-40 x 3/4" socket head screws and 4-40 lock nuts. Tighten the nuts, but do not crush the underlying wood when tightening.

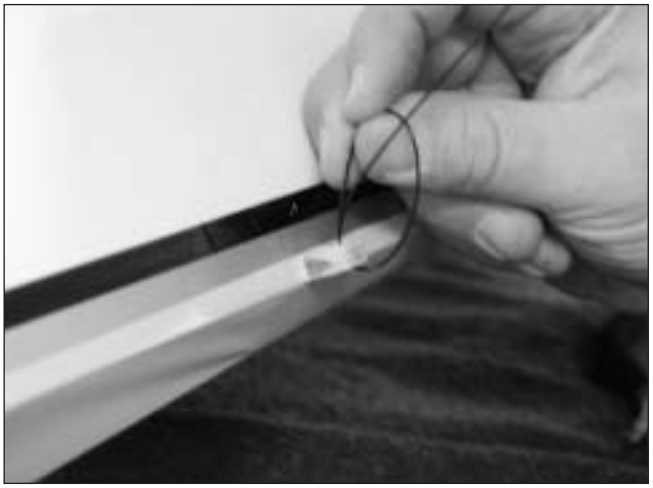
Step 5

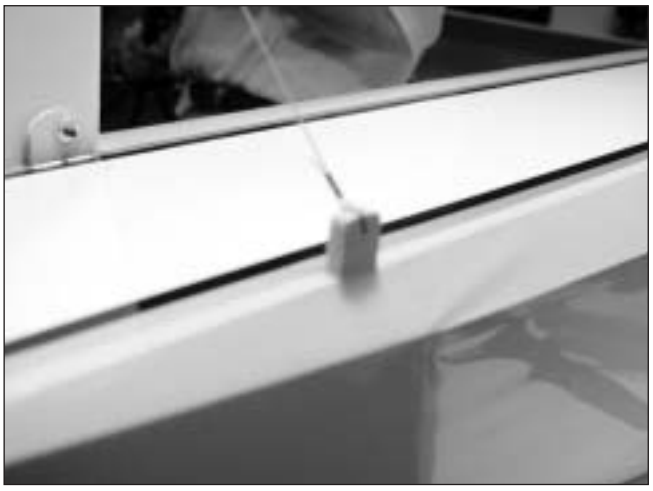
Drill a 1/16" hole in each of the plywood cable attachment tabs on the fuselage. The hole must be centered to provide the greatest strength for the cable attachment. Apply a light coat of medium CA or 6-minute epoxy thinned with denatured alcohol to fuel-proof the exposed wood.



Step 6

Secure the rigging to the lower attachment tabs by threading the cable through the tab as shown. Use crimps to complete the step.





Section 15: Tail Wire Bracing Installation

Step 7

Use the same technique from the previous step to attach the cables to the rigging attachments on the top of the stabilizer.

Step 8

Use rigging couplers, crimps, nuts and clevises to complete the rigging installation. Adjust the clevises so there is light, yet even tension on all the cables. Once adjusted, tighten the nuts onto the clevises to prevent them from loosening during flight.

Section 16: Tail Wheel Installation

Required Parts

- Fuselage assembly
- 1 1/2" tail wheel
- 1/8" wheel collar w/set screw (2)
- Tail wheel bracket
- Tail steering spring (2)
- #6 washer (2)
- #6 x 1/2" sheet metal screw (2)
- #2 x 1/2" sheet metal screw (2)

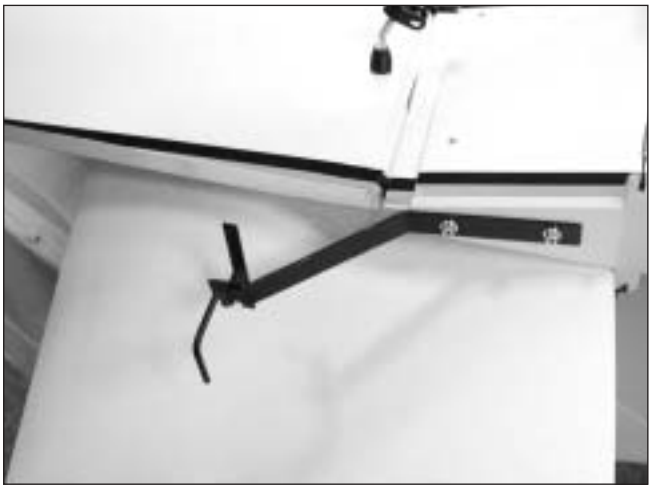
Required Tools and Adhesives

- Wrench
- Drill bit: 3/32”
- Drill
- Thin CA
- 6-minute epoxy

Note: The tail wheel assembly shown is not included.

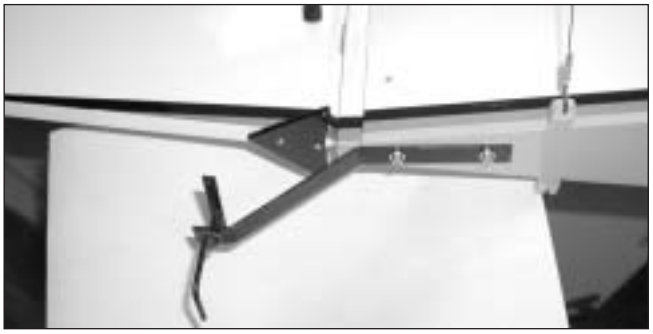
Step 1

Locate the tail wheel bracket. Position the bracket onto the bottom of the fuselage and mark the location for the holes using a felt-tipped pen. Drill the locations using a 3/32" drill bit. Apply 2 to 3 drops of thin CA to the holes to harden the wood. Attach the bracket using two #6 x 1/2" sheet metal screws and two #6 washer.



Step 2

Make a steering plate using scrap 1/8" plywood. Secure the plate to the bottom of the rudder using two #2 x 1/2" sheet metal screws.



Step 3

Install the steering springs as shown.

Step 4

Install the tail wheel using two 1/8" wheel collars and two 4-40 set screws.

Section 17: Main Landing Gear Installation

Required Parts

- Fuselage assembly
- #10 washer (4)
- 10-32 x 1 1/4" socket head screw (4)
- 10-32 lock nut (4)
- Landing gear

Required Tools and Adhesives

- Felt-tipped pen
- Drill
- 30-minute epoxy
- Drill Bit: 3/16"
- Sanding bar
- Epoxy brush

Step 1

Locate the hardware necessary to mount the landing gear.

Step 2

Position the main landing gear onto the fuselage. Be sure the gear is swept rearward. Transfer the location of one bolt onto the fuselage using a felt-tipped pen.

Step 3

Remove the gear and drill the location of the bolt using a 3/16" drill bit.

Step 4

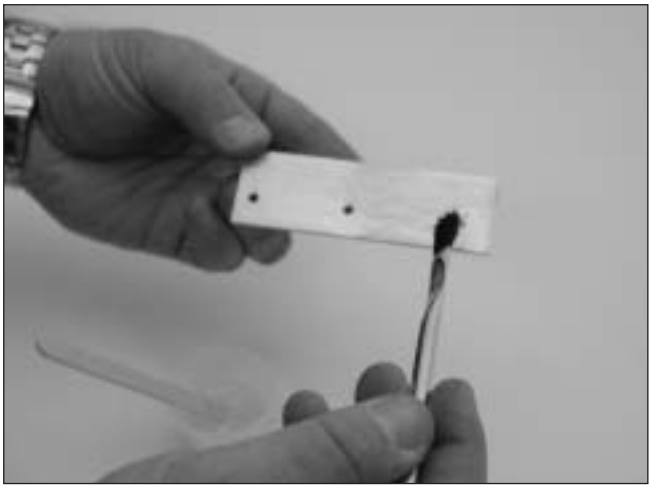
Temporarily attach the gear with one 10-32 x 1 1/4" bolt, #10 washer, and 10-32 lock nut. Drill the locations for the remaining three holes using a 3/16" drill.

Step 5

Remove the gear. Mark the aluminum gear support plates so they can be returned to their original locations. Remove the plates and sand the two surfaces that rest against the inside of the fuselage on each support plate.

Step 6

Mix 1 ounce of 30-minute epoxy. Apply a light coat of epoxy to the surfaces sanded in the last step.



Step 7

Bolt the plates back into the fuselage using their original hardware. Attach the landing gear using four 10-32 x 1 $^{1}/_{4}$" bolts, four #10 washer, and four 10-32 lock nuts.

Section 18: Wheel Pant Installation

Required Parts

- Fuselage assembly
- 4 1/2" main wheel (2)
- 4-40 blind nut (4)
- #4 washer (4)
- 4-40 x 1/2" socket head screw (4)
- 3/16" x 2" axle w/lock nut (2)
- 3/16" wheel collar w/set screw (4)

Required Tools and Adhesives

- Felt-tipped pen
- Thick CA
- Drill
- Ruler
- Drill Bit: 1/8", 5/64", 1/2"

Step 1

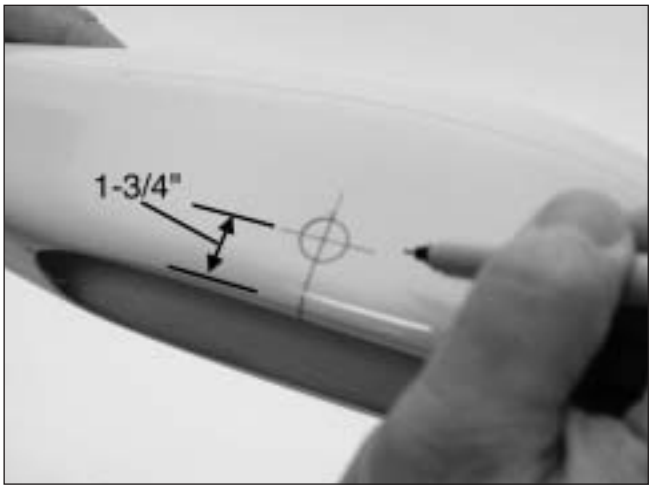
Secure the axles to the main landing gear using the nuts provided with the axles.

Step 2

Measure and mark the center of the wheel opening in the wheel pant.

Step 3

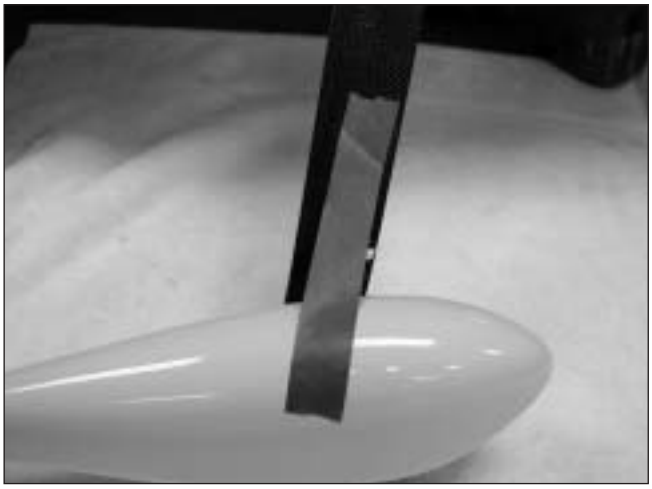
Measure and mark the location for the axle on the wheel pant. The center of the axle will be located 1 3/4" up from the bottom of the pant. Drill the location using a 1/2" drill.



Hint: You can also drill the holes a smaller size then use a tapered reamer and/or a sanding drum to enlarge them to 1/2".

Step 4

Slide the wheel pant over the axle and onto the landing gear. Set the fuselage level, then level the wheel pant. Use tape to hold the wheel pant in position for the next step.



Step 5

Use a 1/8" drill bit to drill the two holes for the wheel pant mounting screws.

Step 6

Remove the tape and the wheel pant. Re-drill the locations for the screws using a 5/64" drill bit to accommodate the blind nuts.

Step 7

Insert two 4-40 blind nuts from the inside of the wheel pant. Use thick CA to secure the position of the nuts. Use care not to get CA into the threads of the nuts.

Section 18: Wheel Pant Installation

Step 8

Install the wheel pant and wheel. Use two 4-40 x 1/2" socket head screws and two #4 washer to secure the wheel pant position. Use two 3/16" wheel collars to keep the wheel on the axle.

Photo for Step 8

Note: Adjust the wheel collars so the wheel is centered side-to-side in the wheel pant.

Section 19: Cabane Strut Installation

Required Parts

- Fuselage assembly
- Cabane strut (4)
- Cabane cross brace (2)
- Carbon center rib
- #8 washer (12)
- 8-32 lock nuts (12)
- 8-32 x 3/4" socket head bolts (12)

Required Tools and Adhesives

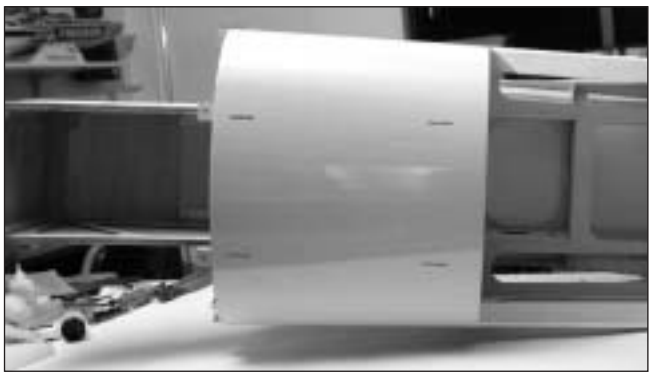
- Hobby knife
- Hex wrench
- Socket wrench

Step 1

Locate the parts necessary to assemble the cabane struts.

Step 2

Locate the holes in the top of the fuselage for the cabane struts. Use a hobby knife to remove the covering from the holes.



Step 3

Slide the cabanes into position. The front cabane only has holes at the top and bottom, while the rear has a hole near the top of the fuselage.

Step 4

Secure the cabanes into position using twelve 8-32 x 3/4" socket head bolts, twelve #8 washer, and twelve 8-32 lock nuts. Place the washers on the backside against the plywood.

Step 5

Install the cross braces. The end with the twist is positioned at the top of the forward cabane. Secure the rear of the braces using 8-32 x 1/2" socket head bolts, #8 washer and 8-32 lock nuts.

Note: The carbon center rib is shown positioned between the struts. The actual installation of the center rib will be done in the Section 24 of the manual.

Section 20: Interplane Strut Installation

Required Parts

- Wing assembly
- #4 washer (8)
- 4-40 x 1/2” socket head bolts (8)
- Interplane attachments (8)

Required Tools and Adhesives

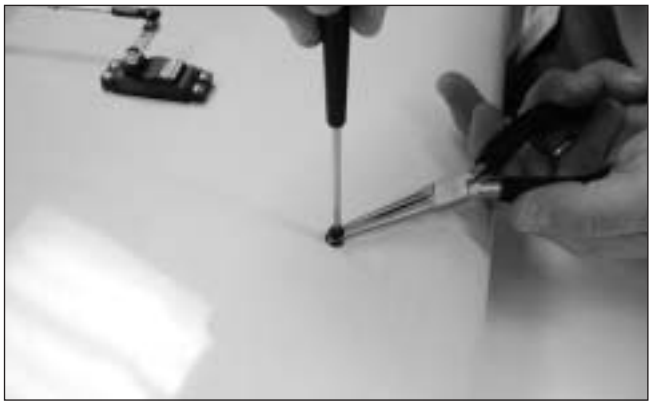
- Pliers
- Hex wrench
- Threadlocking compound

Step 1

Thread the interplane attachments into the wing until the shoulder is flush with the surface of the wing.

Step 2

Secure the attachments using 4-40 x 1/2" socket head screws and #4 washer from the opposite side of the wing. Use a drop of threadlocking compound on the 4-40 screws to prevent them from loosening during flight.



Note: The attachments must be aligned fore-aft as shown.

Section 21: Bottom Wing Installation

Required Parts

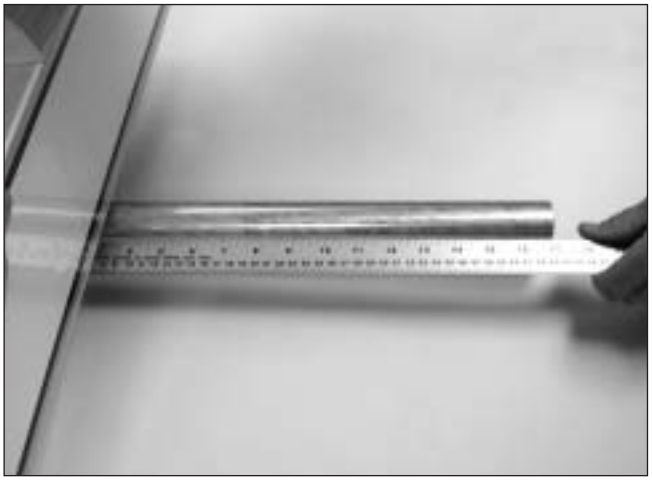
- Bottom wing assembly
- Fuselage assembly
- Wing tube
- 1/4-20 blind nut (2)
- 1/4-20 x 2" nylon bolt (2)

Required Tools and Adhesives

- 30-minute epoxy

Step 1

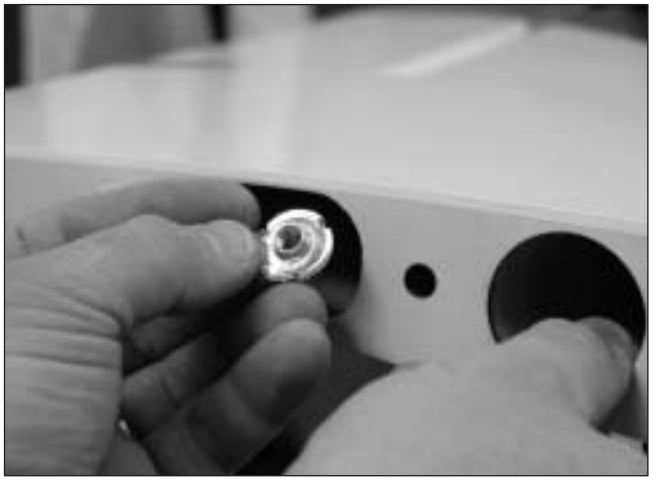
Install the wing tube into the fuselage. Measure the distance the tube extends from both sides of the fuselage and adjust until equal.

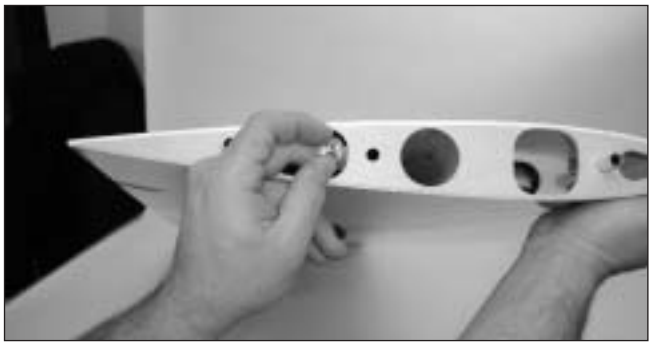


Note: Perform a dry run of the next step before mixing any epoxy.

Step 2

Mix 1/2 ounce of 30-minute epoxy and apply it to a 1/4-20 blind nut. Insert the blind nut into the wing as shown. Allow the epoxy to fully cure before moving to the next step. Repeat this step for both the left and right bottom wing panels.





Section 21: Bottom Wing Installation

Step 3

Slide the wing into position. Make sure the wing rests flush with the fuselage. Secure each wing panel using a 1/4-20 x 2 nylon bolt.

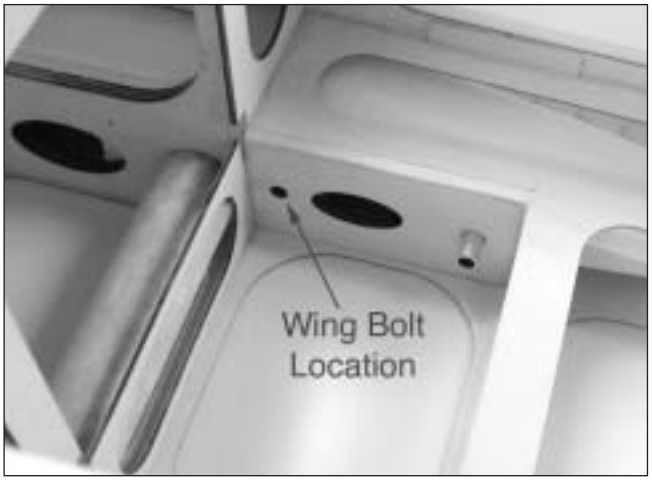


Photo for Step 3

Section 22: Top Wing Installation

Required Parts

- Top wing assembly
- Fuselage assembly
- Wing tube
- 4-40 washer (2)
- 4-40 x 1/2" socket head bolt (2)

Required Tools and Adhesives

- Tap: 4-40
- Tap handle
- Drill Bit: #44
- Drill
- Sandpaper (medium)
- Hobby knife

Step 1

Test fit the wing tube into the carbon center rib. It may be necessary to lightly sand the opening in the rib to get the tube to fit.

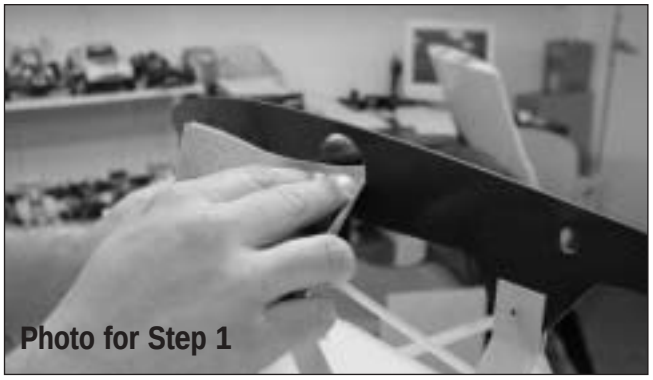


Photo for Step 1

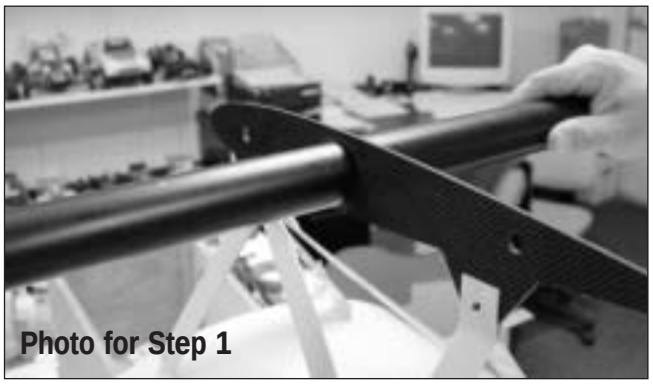
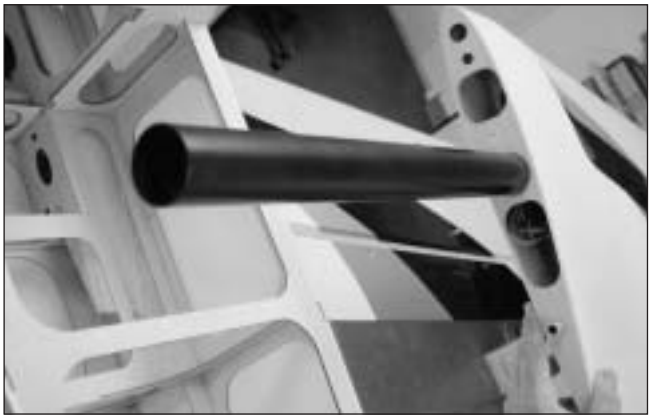


Photo for Step 1

Step 2

Slide the tube into one of the top wing halves.



Step 3

Slide the wing panel into position. The panel will rest flush against the center rib wing installed correctly. You may need to lightly sand the openings for the anti-rotations pins to get the panel to fit snug against the center rib.

Step 4

Slide the remaining top wing panel onto the tube and against the center rib.

Section 23: Interplane Strut Installation

Required Parts

- Interplane strut (2)
- #6 nylon washer (8)
- Fuselage assembly w/wings
- 6-32 x 1" socket head bolts (8)
- 6-32 blind nut (8)

Required Tools and Adhesives

- Hobby knife

Step 1

Locate the holes in the interplane struts. Remove the covering from both sides of the holes.

Step 2

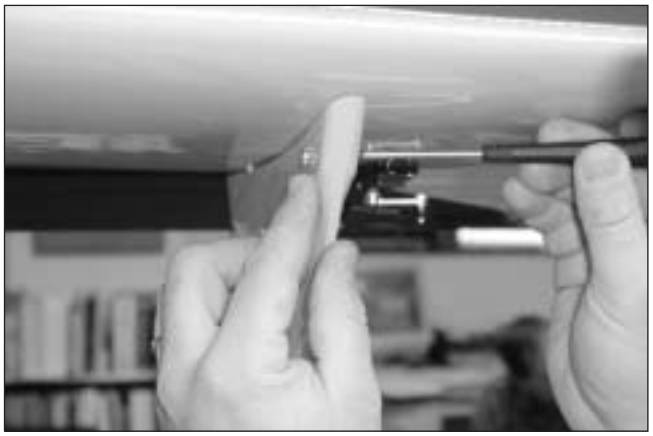
Place on strut into position. Make sure the curves on the strut follow the airfoil of the wings. The strut attachments will be hidden inside the struts.

Step 3

Install the remaining strut. Note that after the cabane rib is installed you will need to apply some pressure to separate the top and bottom wings enough to fit the remaining strut into position when assembling the model.

Step 4

Place a #6 washer onto a 6-32 x 1" screw. Slide the screw through the strut and strut attachment. Thread a 6-32 blind nut onto the exposed threaded portion of the screw. Tighten the screw into the blind nut, drawing the blind nut into the strut. Repeat this step for all eight screws.



Section 24: Setting the Incidence

Required Parts

- #8 washer (2)
- 8-32 lock nuts (2)
- Carbon center rib
- Fuselage assembly w/wings
- 8-32 x 1/2" socket head bolts (2)

Required Tools and Adhesives

- Drill Bit: 11/64"
- Drill
- Clamps
- Incidence meter
- Ruler
- Felt-tipped pen
- Hobby knife

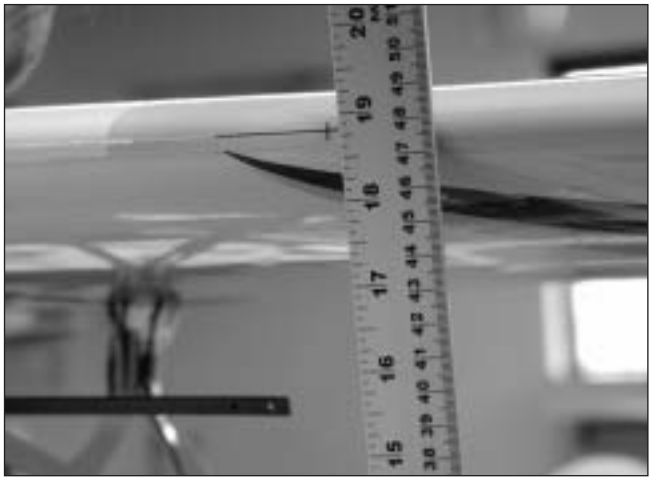
Note: The section references the incidence of the top wing to the bottom wing. It is essential the incidence of the top wing be set using the method described in this section. The stabilizer incidence and engine thrust angle are not referenced during this section.

Step 1

Position the carbon center rib between the cabane struts. Use clamps to hold the rib in position. Be sure to align the left and right attachment holes of the cabanes with each other.

Step 2

Mark centerlines on the leading edge of the top and bottom wings. Make a set of marks near the fuselage, and a set near the Interplane struts.



Step 3

Measure the distance between the two sets of marks. The measurement between the marks near the fuselage and at the struts should be equal. Adjust the position of the center rib until they are equal.

Step 4

Place an incidence meter on the bottom wing near the fuselage. Adjust the angle of the fuselage until the meter reads “0.” Block the fuselage so it will remain at this angle for the remainder of this section.

Step 5

Measure and record the incidence of the top wing. It should read 1/2 degree negative in comparison to the bottom wing (leading edge lower than trailing edge).

Step 6

Adjust the center rib to achieve the correct incidence. Re-check the measurements made in Step 3. Once the incidence is set, and the top and bottom wings are an equal distance apart, drill the mounting holes in the center rib using an 11/64" drill bit.

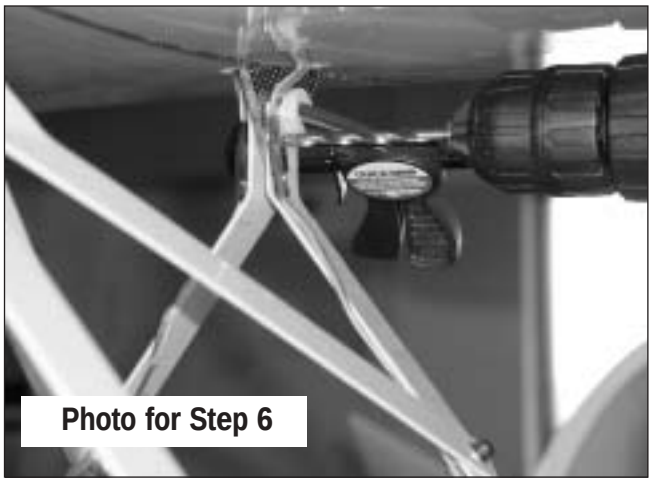


Photo for Step 6

Step 7

Secure the center rib using two 8-32 x 1/2" socket head bolts, two #8 washer, and two 8-32 lock nuts.

Step 8

Locate the holes for the wing tube locking screws. Use a hobby knife to remove the covering from the holes.

Section 24: Setting the Incidence

Step 9

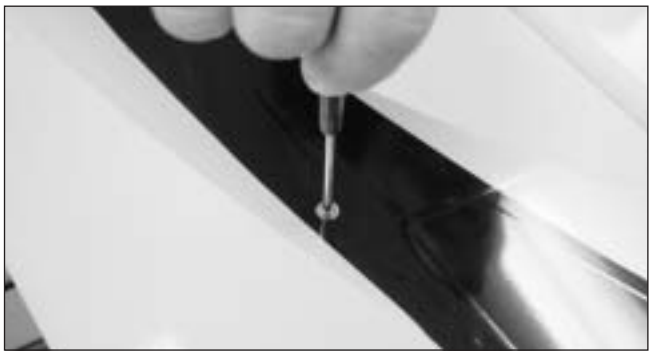
Drill a hole in the wing tube using a #44 drill bit. Drill only through the top side of the tube.

Step 10

Tape the hole drilled in the last step using a 4-40 tap.

Step 11

Secure the tube using a 4-40 x 1/2" screw and #4 washer.



Section 25: Engine Box Preparation

Required Parts

- Fuselage assembly

Required Tools and Adhesives

- Drill bit: 1/8"
- 1/8" dowel
- Razor Saw
- Drill
- 30-minute epoxy

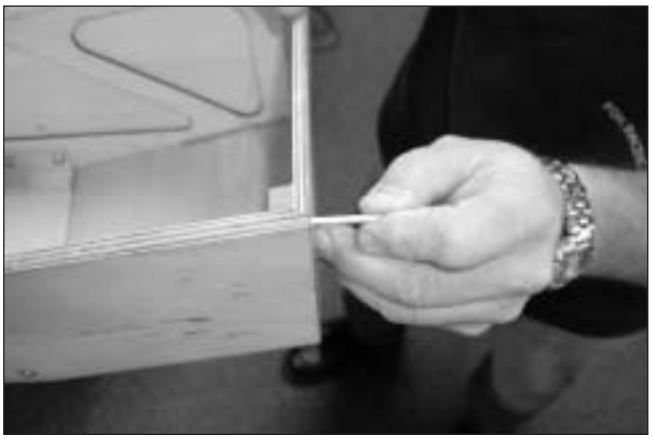
Note: Do not skip this step. Because of the nature of this plane, the gyroscopic forces generated from the engine, transferred to the firewall, could possibly break it loose from the engine box. It is necessary to pin the corner supports to prevent this from happening.

Step 1

Measure and mark three evenly spaced locations on each vertical corner of the engine box. Drill the locations using an 1/8" drill.

Step 2

Cut a 1/8" dowel into twelve 1" lengths. Apply 30-minute epoxy to one end of the dowel piece and into one hole. Slide the dowel into the hole. Allow the epoxy to cure before moving to the next step. Repeat this step for all 12 dowels.



Step 3

Use a razor saw to cut the excess dowel.

Step 4

Sand the dowels flush with the front and sides of the engine box.

Section 26: Mounting the Engine

Required Parts

- Fuselage assembly
- Engine
- 1/4-20 blind nuts (4)
- 4" Pro-Link (HAN3555)
- 1/4" plywood engine box cover
- 1/4-20 x 1" socket head bolts (4)
- 4-40 x 1/2" servo arm for JR (HAN3574)

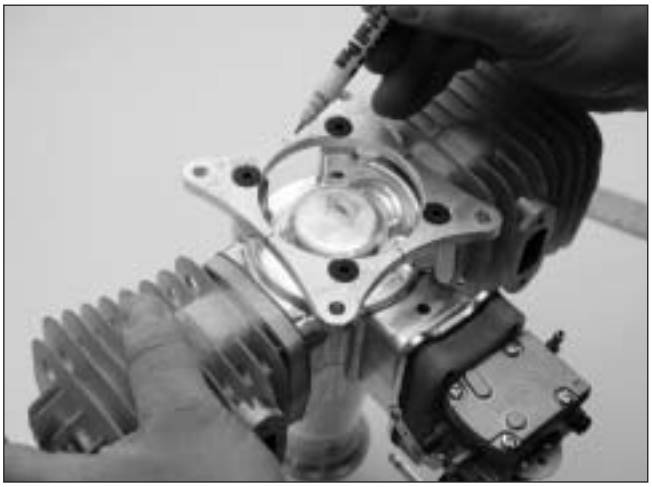
Required Tools and Adhesives

- Drill Bit: 5/16"
- Drill
- Felt-tipped pen
- Ruler
- Clamps
- Razor saw
- 1/8" plywood scrap
- 30-minute epoxy
- Masking tape

Note: Our Ultimate was assembled and flown using a Desert Aircraft DA150. Although the DA150 is shown, any suitable engine can be installed using the steps as described.

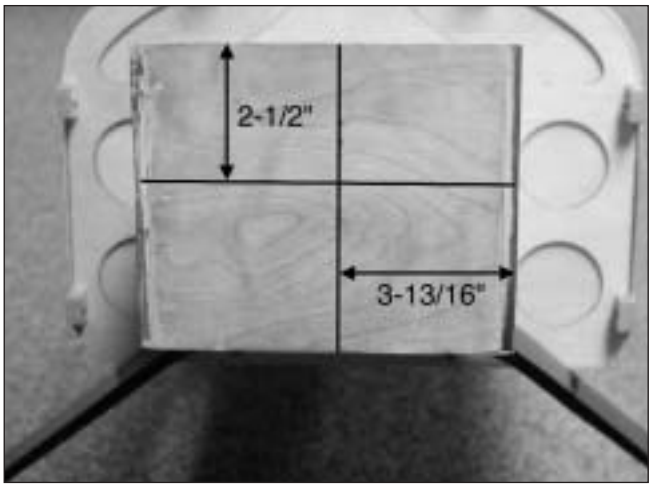
Step 1

Locate the centerline on your particular engine.



Step 2

Draw a vertical and horizontal centerline on the firewall. The horizontal line is located 2 $^{1}/_{2}$" from the top of the firewall, and the vertical line 3 $^{13}/_{16}$" from the left side of the firewall.



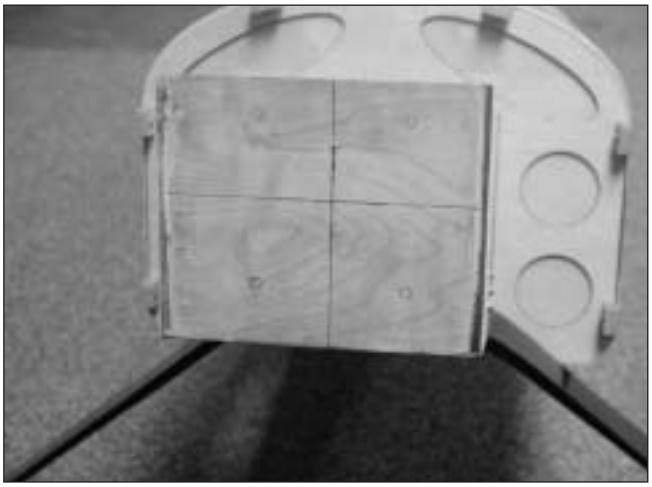
Step 3

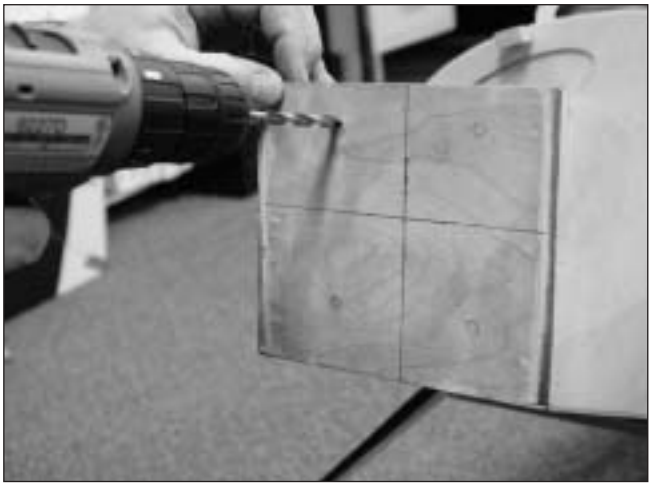
Position your engine so it aligns with the centerlines drawn in the last step. Use clamps to hold the engine in position. Slide the cowl onto the fuselage, and temporarily attach the cowl to the fuselage. Install the spinner and check the alignment with the cowl. Make any necessary adjustments to the position of the engine to get proper alignment between the spinner and cowl. Remove the cowl and mark the location for mounting the engine.

Photo for Step 3

Step 4

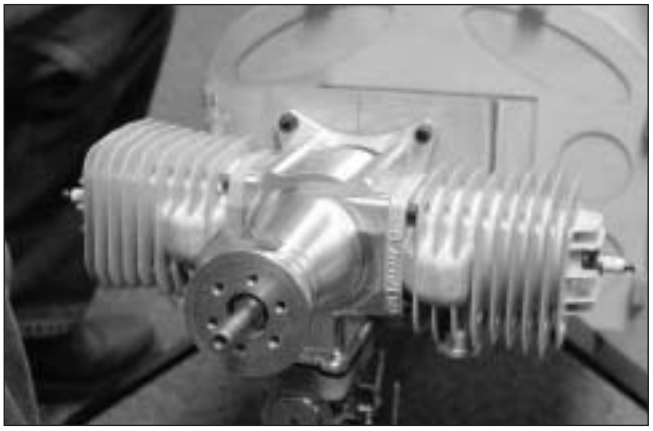
Remove the clamps holding the engine and set the engine aside. Use a 5/16" drill bit to drill the locations for the mounting screws.

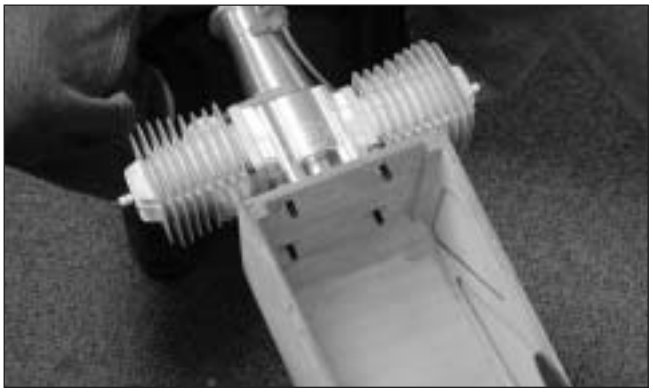




Step 5

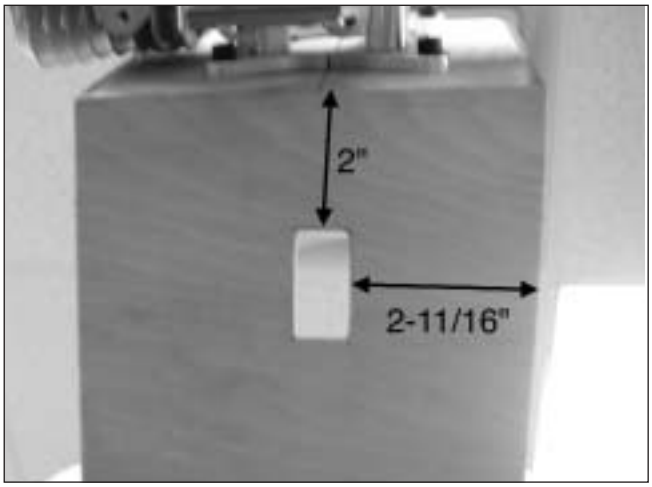
Mount the engine using four 1/4-20 x 1" socket head bolts and four 1/4-20 blind nuts. Apply thick CA to the back of the blind nut to hold it in position.





Step 6

Cut a hole in the bottom of the engine box for the throttle servo.



Section 26: Mounting the Engine

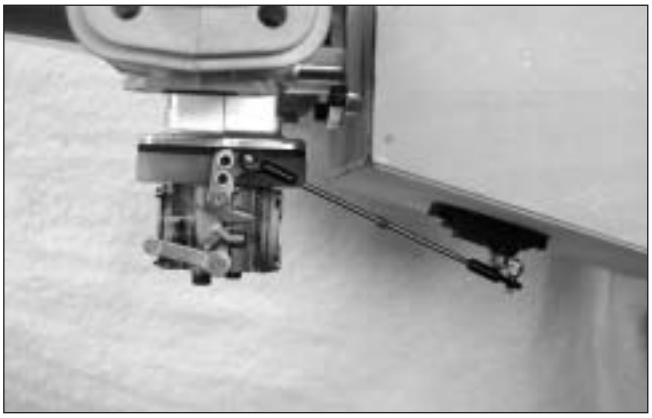
Note: If you are using a DA150, the location for the servo is 2" back from the firewall and 2 $^{11}/_{16}$" from the left side of the engine box. This location may work for other engines also.

Step 7

Cut two pieces of 1/8" plywood to 1" x 1/2". Glue the pieces to the front and rear of the servo opening.

Step 8

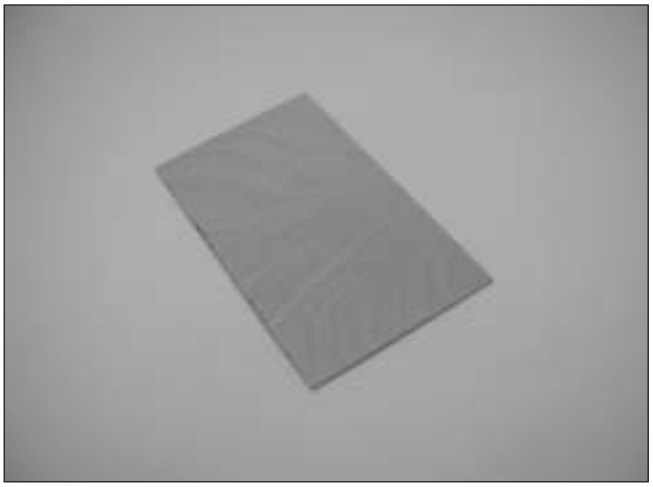
Install the throttle servo and connect a linkage from the servo to the throttle arm.



Note: We used a 4-40 x 1/2" servo arm for JR (HAN3574) and 4" Pro-Link (HAN3555) to work with the DA150 engine.

Step 9

Locate the 1/4" plywood engine box cover. Test fit the cover onto the engine box. It should be noted that there is a slight angle on one of the short ends to accommodate the thrust angle of the firewall.



Note: The engine box cover can also be attached by screws, which would allow for access inside the engine box if necessary.

Step 10

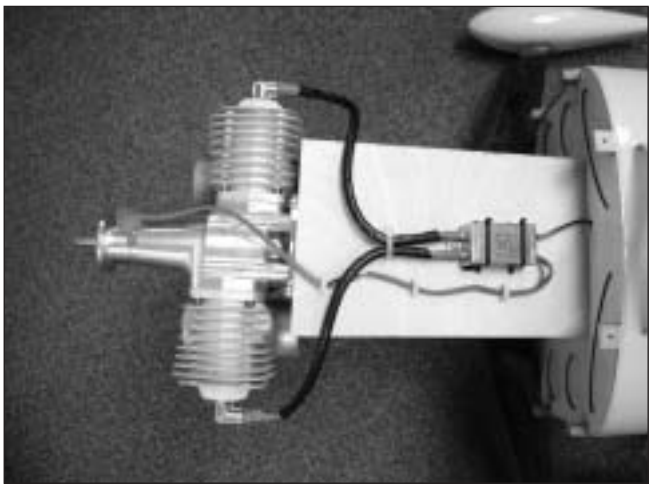
Mix 1 ounce of 30-minute epoxy. Apply the epoxy to top edge of the engine box. Place the engine box cover onto the box and use tape to hole it in position until the epoxy fully cures.

Step 11

Once the epoxy has fully cured,use finishing resin and fuel-proof any exposed bare wood.

Step 12

Install the necessary support equipment for your particluar engine.



Section 27: Mounting the Cowling

Required Parts

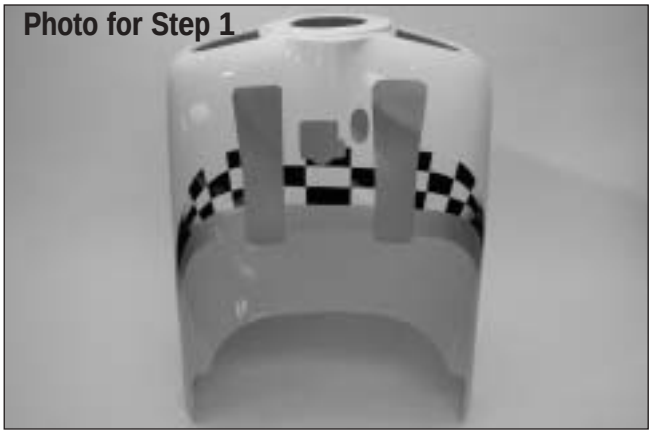
- Fuselage assembly
- Cowl
- Pre-cut fuel tube (6)
- #4 washer
- 4-40 x 1/2" socket head bolt (6)

Required Tools and Adhesives

- Razor Saw
- Canopy scissors
- Rotary tool w/sanding drum

Step 1

Test fit the cowling onto the fuselage. Make any necessary adjustments to the cowl to provide access for mufflers, carburetor, choke lever, etc.



Step 2

Slide a washer onto a 4-40 x 1/2" socket head screw. Slide the fuel tubing onto the screw. The fuel tubing will prevent damage to the cowl, and keep the screws from vibrating loose during flight. Secure the cowl using six 4-40 x 1/2" socket head screws, six #4 washers and the six pieces of fuel tubing.

Section 28: Mounting the Canopy

Required Parts

- Fuselage assembly
- 40% Pilot Figure
- Canopy
- Instrument panel

Required Tools and Adhesives

- Razor Saw
- Masking tape
- Sandpaper (medium)
- RCZ56 Canopy Glue (ZINJ5007)
- Canopy scissors
- Felt-tipped pen

Step 1

Install any instrument panel details is desired.

Step 2

Install a pilot of your choosing. We used a 40% civilian pilot from MDG (MGD401) for our Ultimate. Use epoxy or Zap-A-Dap-A-Goo to secure the pilot.

Step 3

Position the canopy onto the canopy hatch. Trace around the canopy and onto the hatch using a felt-tipped pen.

Step 4

Lightly sand the inside edge of the canopy and slightly inside the line drawn on the hatch using medium sandpaper.

Section 28: Mounting the Canopy

Step 5

Apply a bead of RCZ56 Canopy Glue (ZINJ5007) around the inside edge of the canopy. Position the canopy onto the hatch. Use tape to hold the canopy secure until the glue fully cures.

Photo for Step 5

Section 29: Final Radio Installation

Required Parts

- Fuselage assembly
- Top wing assembly

Required Tools and Adhesives

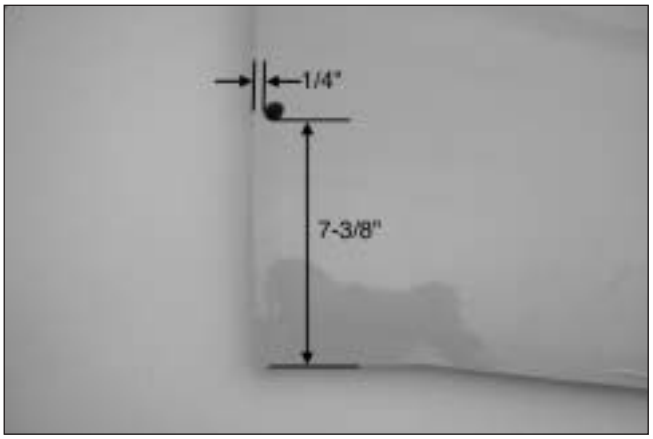
- Hobby knife
- Rotary tool w/sanding drum

Step 1

Cut two small notches on the inside edges of the rear cabane struts. This is where the servo leads will pass through for the top wing.

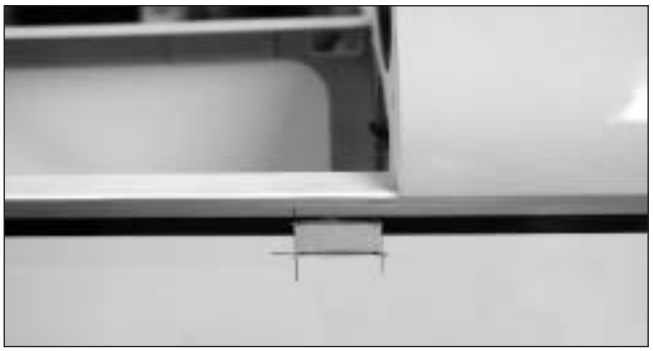
Step 2

Cut a hole in the bottom of the top wing panels for the servo leads to pass through. The hole is located 7 $^{3}/_{8}$" forward of the trailing edge and 1/4" from the root of the wing.



Step 3

Cut holes to mount the radio switches.



Step 4

Secure the receiver, receiver battery, and all other miscellaneous radio equipment inside the fuselage.

Control Throws and Center of Gravity

Recommended CG Location

An important part of preparing the aircraft for flight is properly balancing the model. This is especially important when various engines are mounted.

Caution: Do not inadvertently skip this step!

The recommended Center of Gravity (C.G.) location for the Ultimate is 9 $^1/_8$" behind the leading edge at the center of the top wing. It may be necessary to either build a harness, or project the balance point to the wing tips, in order to lift the aircraft. If necessary move the battery packs.

The following control throws offer a good place to start with your first flights. We recommend only one rate setting for the Ultimate. As you become more familiar with the handling of your model, you may wish to add a second rate setting.

Once the control throws have been set, tighten all the hardware involved to prevent loosening during flight. It is also highly suggested to use thread locking compound on any metal to metal items.

Recommended Control Throws

	Low rate	3D Rate
Aileron	26° up	41° up
	25° down	40° down
Elevator	15° up	33° up
	20° down	31° down
Rudder	31° left	37° left
	31° right	37° right

Preflight at the Field

☐ **Step 1**

Before each flying session, range-check your radio. This is accomplished by turning on your transmitter with the antenna collapsed. Turn on the radio in your airplane. With your airplane on the ground, you should be able to walk 30 paces away from your airplane and still have complete control of all functions. If not, don't attempt to fly! Have your radio equipment checked out by the manufacturer.

☐ **Step 2**

Double-check that all controls (aileron, elevator, throttle, rudder) move in the correct direction.

☐ **Step 3**

Before you fly, be sure that your batteries are fully charged per the instructions included with your radio.

Adjusting the Engine

Completely read the instructions included with your engine and follow the recommended break-in procedure.

Before you fly, be sure that your engine idles reliably, transitions and runs at all throttle settings. Only when this is achieved should any plane be considered ready for flight.

Setup and Flight Information by Mike McConville

Our new 46% Ultimate 10-300 is a truly extraordinary model that has been developed over the past 10 years. Originally developed for the 1994 Tournament of Champions, the first version featured very thing wings. Because engines were less developed in 1994, the goal was to make the Ultimate as streamlined as possible and thus very thin wings, which required functional flying wires were used. This proved to be more trouble that it was worth. Further testing and analysis proved that by increasing the wing section to its current 12% thickness, the flying wires could be removed, and yet because of the extreme drag caused by the flying wires, the net result was an even more streamlined model.

We've found that the modern breed of 150cc engines such as the popular DA-150 provides all the horsepower needed to fly even the Unlimited IMAC, Masters and TOC sequences. While a 200cc engine will fit inside the cowl, we've found that a 150CC will even provide completely unlimited power for even all the 3D flying you can dish out.

When designing this final version of the Ultimate, I incorporated every design features and enhancement that would make it a top level Tournament of Champions and IMAC model. Does this mean the Ultimate is only for the serious competitor? Absolutely not! What this does mean is that the Ultimate is fine-tuned and tweaked to excel in both precision aerobatics and wild freestyle type 3D, so doing any aerobatics will be easier than it has ever been. I've found the inherent drag of the biplane design makes all downlines very slow, giving you lots of time to think, correct and make everything look just right.

Preflight

Before getting to the really fun stuff, flying, I'd like to reiterate some very important steps that were covered in the assembly instructions. For those of you who are veterans of large models, this is old news. But to you new comers to the world of large models, this is very important information.

While many smaller models are very tolerant of improper control linkage setups and flying techniques, large models are not. Don't let that scare you away from large models; they are truly one of the best flying experiences in R/C that money can buy. However, please pay particular attention to the following areas:

Seal the aileron and elevator hinge gaps.

This should be considered part of finishing the model and is as important as installing the fuel tank or battery pack. On large aerobatic models, this is absolutely necessary. Failure to do this could promote control surface flutter, and on a large model, this will most likely cause a crash. Putting safety and model preservation to the side, there are several other reasons to do this on an aerobatic model. It will increase the effectiveness of the control surfaces, and the model will track more true and precise. Hinge gaps sealed? CHECK!

Maintain the proper mechanical advantage on all control surface linkages.

Same as unsealed hinge gaps, this is often the cause of flutter. Please follow the control horn and servo arm lengths recommended in this manual. Shorter arms on the servo or longer control horns on the elevator and ailerons are fine, but do not try to go the other way to increase throw. It can cause flutter on any model. The recommended linkage setups are more than adequate to achieve full 3-D performance. That's straight off of the prototypes. Linkages are set? CHECK!

Never attempt to make full throttle dives!

Large models perform much more like full-size aircraft than small models. If the airframe goes too fast, such as in a high throttle dive, it may fail. Throttle management is absolutely necessary. If the nose is down, the throttle comes back. CHECK!

The Prototype Model Setup

All of the recommended settings in this manual are a result of the flight-testing on the prototype Ultimates. There are no secrets. If you follow the instructions and these tips, your Ultimate will be set up just like mine. Although a computer radio is not mandatory, it is highly recommended in this model. I use exponential on all controls to soften the feel around neutral. This makes it easier to fly smooth in precision maneuvers and also makes it less likely to over-control in 3D mode. I use the following expo values: Elevator +42% Low Rate, +70% 3D Rate. Aileron +65% Low Rate, +70% 3D Rate. Rudder +46% Low Rate, +55% 3D Rate. Note that + expo values soften the neutral with JR radios. Other brand systems may require "-" (negative) expo values to soften the neutral.

All flying of the Ultimate was done using JR 8411 digital servos. I use a 6V battery pack for maximum speed and torque from the servos. The Ultimate does have a very large rudder and requires a lot of servos power. I found that the best way to get the needed servo power is to use a JR Matchbox for all four rudder servos and **power them with their own 6V battery supply**.

The prototype Ultimates were tested on my favorite power plant, the Desert Aircraft DA-150. I use a Mejelik 32 x 10. This combination has proven to be totally unlimited and allows anything imaginable from torque rolls just a few inches off the ground to multiple vertical snaps.

Computer Radio Enhancements

A computer radio will allow quite a bit of fine-tuning of the feel of the Ultimate, making aerobatics even easier. Below are programming enhancements normally used to trim out an aerobatic model.

- **Rudder-to-Elevator and Rudder-to-Aileron Mixing**

This mix is used to dial out unwanted pitch or roll caused by the rudder. The Ultimate has very little pitch coupling, actually less than most popular monoplane designs. Roll coupling is present as with any bi-plane design but dialing it out will make knife-edge maneuvers easier. Use a preprogrammed mix if your radio has this feature, or if not, use a P-mix feature. Assign rudder as the master channel and aileron as the slave. Set the mixing values to approximately 10% so when the rudder is deflected in a direction, the ailerons move slightly in the opposite direction of the stick movement. Also mix the elevator to rudder and set the mix values to 5%, so when the rudder stick is moved either direction the elevator moves up slightly. These are good starting points, but you will need to fine-tune this as part of your flight trimming process.

- **Spoileron Mixing**

This can be achieved by using either a preprogrammed elevator to flap mix or a P-mix. Assign elevator as the master channel and flap as the slave. Set the mix values so that when full up, 3D elevator is given, both ailerons also go up 35 degrees. This mix helps stabilize the model in some 3D maneuvers, such as the Elevator and Harrier.

- **Throttle Curve**

This is normally a preprogrammed function. It can also be achieved in radios that do not have this premix but do have curve type P-mixing by mixing throttle as the master and slave channels. Adjust the curve to get the desired throttle servo response. This is particularly useful to get an engine to "act" linear throughout the entire throttle stick movement. I also use this at times to make the throttle response less sensitive in the rpm ranges used for hovering the model. This makes altitude control easier and smoother when doing torque rolls.

Setup and Flight Information by Mike McConville

Rates and Expos: When and Where to Use Them

I Always use expo to soften the feel of the model. On high 3D rates, I use quite a bit. The goal on 3D rates is to get the model to feel the same around neutral as it does on low rates. I use low-rate settings for all flying except for 3D aerobatics. For precision flying or general sport hot-dogging, the low rate throws are perfect, even for snap rolls. The only exception is rudder rates. I go to 3D rate when doing stall turns and rolling circles, since the more rudder the better for these. When doing 3D aerobatics, I normally flip to 3D rates just before the maneuver. As soon as the maneuver is done, I flip back down to low rate to avoid over-controlling the model.

Let's Get Down To It

When flying aerobatics with a larger model, you will find that it will do everything just like a smaller model… only better and easier. There are just a few exceptions to how things are done. Throttle management is a must. You have to throttle back to idle when the nose is pointed down.

Snap Rolls

Just like the need to be throttle managed like a full-scale airplane, larger aerobatic airplanes need to be snapped like a full scale. Let's back up to how we all learned to do a snap roll. If it's an inside (positive) snap, we pull the sticks into the corner, i.e. full up, full aileron, and full rudder in the same direction as aileron. When we want to stop snapping, we release the controls. For smaller models, this technique not only works but also is normally the only way to get the model to snap. In a full-scale aerobatic plane, as well as with large models, snaps are different, particularly on the new breed of aerobatic birds like the Ultimate, which have large control surfaces.

Unloading Snaps

To start a snap roll, the same method as with a smaller model is used. Pull full up, full rudder, and aileron in the same direction. But soon as the sticks reach the corners, neutralize the elevator while keeping the rudder and ailerons at full deflection. When you do this correctly,
the Ultimate will not get "deep" into snaps. This allows it to keep more airspeed as it exits the snap, so it stops snapping where you what it to and flies out with more air speed. You'll also find that it will be easier to exit a snap heading the same direction you were when you entered the snap. It'll take a little practice to get the hang of "flying" the snaps, but I'll bet you'll see a big improvement in the quality of your flying.

Ultimate at Its Best

3D maneuvers (in simplest terms) are maneuvers performed by an airplane that are not usually done in a normal airplane flight path. What can be done with a 3D plane is to make it fly like no other. For example, hovering in the air nose high at a 45-degree descent, floating along in level flight or hanging on the prop. When you sprinkle these maneuvers together with other loops, rolls, snaps, and spins, it seems like the aerobatic options are endless. To fly 3D, you must have a plane that's capable. What's capable? Well, it starts with having outlandish pitch control from having huge elevators. The same applies, but not to the same extent, with rudder and ailerons. When it comes to 3D aerobatics, our Ultimate is surprisingly capable and puts to rest some theories that biplanes are not 3D capable airplanes.

The Maneuvers

Let's cover the seven 3D maneuvers where the Ultimate really excels.

• The Blender

What it is: The Blender or Panic maneuver is a vertical diving roll that virtually stops its descent as it instantaneously enters into a flat spin.

Setup: Follow the 3D setup as described in the manual. Be sure to use Expo. This is a wing tester and can be extremely violent if not done correctly but will always generate gasps of excitement. Done correctly, the Ultimate can handle the challenge.

How to do it: Start from about 400-500 feet straight and level, chop throttle, and push the nose straight down. As soon as the model is diving straight down at low throttle, add full left aileron. Let the model compete two or three rolls and then quickly transition the sticks to an inverted snap roll position (left aileron, right rudder, down elevator) all at the same time. As soon as the Ultimate enters a spin, quickly neutralize the ailerons while holding full right rudder and down elevator. If you do it right, the airplane will instantly transition from a left roll to a flat spin in the same direction, and the decent will all but stop.

Tip: Add full throttle just after the spin goes flat. That will keep fuel going to the engine, make the rotation speed high, and help stop the vertical decent.

Recovery: Simply release rudder and hold just a little down elevator. The model will stop rotating and begin to fly out. As it gains airspeed, roll back to upright. Since you're in 3D mode, make sure you don't do anything abrupt, or you'll stall again.

• The Elevator

What it is: The plane drops vertically while in a nose high attitude. Depending on the head wind conditions, the model will drop anywhere from about a 45° angle in calm conditions to vertical or even a little backwards in more windy conditions. Throttle is used to determine rate of descent and the nose high attitude of the model.

Setup: Follow the 3D setup as described in the manual. Be sure to use Expo. Flip the switch to turn on the spoilerons. This will allow the Ultimate top drop at a steeper angle.

How to do it: At near stall airspeed up high, slowly feed in up elevator until you have the full 3D rate up in it. With low throttle, the Ultimate will fall like a rock. To guide it around, use the rudder, not ailerons. Just keep the wings level. Add power to change the attitude of your Ultimate.

Trickiest part: Aside from steering it with the rudder, you'll quickly see that this maneuver is a matter of juggling the throttle and rudder to get the plane to go where you want it to go.

Recovery: Basic recovering-add full power, flip to normal rate elevator, and fly out.

Advanced recovery: Take the elevator all the way to the ground, adding some power before it touches to slow the decent and transition into a Harrier.

OR

Add power to get the nose to rise to vertical and transition into a Torque Roll. Elevator down from a hundred feet down to 20 feet (or less) and power up into a torque roll. Ooh!!

Worst way to mess up: Let your direction control (rudder) get away from you after starting too low—you could snap it right into the ground. Ouch!

Setup and Flight Information by Mike McConville

• The Harrier

What it is: It is very slow forward flight in a very nose high (about 45°) attitude.

Setup: Same as the Elevator, and the raised ailerons help in this maneuver even more.

How to do it: Start by entering an Elevator maneuver. Let the Ultimate drop a small amount, then slowly add power until the vertical decent stops and the model begins to fly forward with the nose very high, all the while your holding full up elevator (on 3D rate). Juggle the power to control the attitude and forward speed of the model. In a head wind, you may also have to juggle the elevator some to keep the model from pitching up to a vertical attitude. Use the rudder to steer the model around in the Harrier attitude. Try to use the ailerons very little,
as they will cause the model to wobble side to side.

Trickiest part: Keeping up with the model if it begins to wobble.

Recovery: Simply add full power and reduce elevator to transition into normal forward flight.

• The Torque Roll

This is one of the Ultimates 3D specialties.

What it is: The Ultimate "hovers" vertically in place, rotating left around its roll axis.

Setup: Full 3D throws in elevator and rudder are a must.

How to do it: Fly low along the ground at low throttle and gently add power with up elevator to bring the model into a vertical position. Add throttle to keep the nose pointed up and make corrections with rudder and elevator to keep things straight. If the model hovers but won't start rolling left, quickly blip the throttle up and down. The torque change will usually get it going.

Trickiest part: Recognizing your correction when the model's belly is toward you.

Tip: Think push the rudder toward the low wing when the belly is toward you. You have to be fast with throttle corrections. Add bursts of power, along with rudder/elevator corrections. If you simply hold full throttle, you'll climb out of the maneuver.

Recovery: Fly out at full throttle.

Worst way to mess up: Have an unreliable engine. Torque rolls are tough on engines because there's only prop-induced airflow over the cylinders.

2003 Official AMA National Model Aircraft Safety Code

GENERAL

1) I will not fly my model aircraft in sanctioned events, air shows or model flying demonstrations until it has been proven to be airworthy by having been previously, successfully flight tested.

2) I will not fly my model higher than approximately 400 feet within 3 miles of an airport without notifying the airport operator. I will give right-of-way and avoid flying in the proximity of full-scale aircraft. Where necessary, an observer shall be utilized to supervise flying to avoid having models fly in the proximity of full-scale aircraft.

3) Where established, I will abide by the safety rules for the flying site I use, and I will not willfully and deliberately fly my models in a careless, reckless and/or dangerous manner.

4) The maximum takeoff weight of a model is 55 pounds, except models flown under Experimental Aircraft rules.

5) I will not fly my model unless it is identified with my name and address or AMA number, on or in the model. (This does not apply to models while being flown indoors.)

6) I will not operate models with metal-bladed propellers or with gaseous boosts, in which gases other than air enter their internal combustion engine(s); nor will I operate models with extremely hazardous fuels such as those containing tetranitromethane or hydrazine.

7) I will not operate models with pyrotechnics (any device that explodes, burns, or propels a projectile of any kind) including, but not limited to, rockets, explosive bombs dropped from models, smoke bombs, all explosive gases (such as hydrogen filled balloons), ground mounted devices launching a projectile. The only exceptions permitted are rockets flown in accordance with the National Model Rocketry Safety Code or those permanently attached (as per JATO use); also those items authorized for Air Show Team use as defined by AST Advisory Committee (document available from AMA HQ). In any case, models using rocket motors as a primary means of propulsion are limited to a maximum weight of 3.3 pounds and a G series motor. (A model aircraft is defined as an aircraft with or without engine, not able to carry a human being.)

8) I will not consume alcoholic beverages prior to, nor during, participation in any model operations.

9) Children under 6 years old are only allowed on the flight line as a pilot or while under flight instruction.

RADIO CONTROL

1) I will have completed a successful radio equipment ground range check before the first flight of a new or repaired model.

2) I will not fly my model aircraft in the presence of spectators until I become a qualified flier, unless assisted by an experienced helper.

3) At all flying sites a straight or curved line(s) must be established in front of which all flying takes place with the other side for spectators. Only personnel involved with flying the aircraft are allowed at or in the front of the flight line. Intentional flying behind the flight line is prohibited.

2003 Official AMA National Model Aircraft Safety Code

Continued

4) I will operate my model using only radio control frequencies currently allowed by the Federal Communications Commission. (Only properly licensed Amateurs are authorized to operate equipment on Amateur Band frequencies.)

5) Flying sites separated by three miles or more are considered safe from site-to site interference, even when both sites use the same frequencies. Any circumstances under three miles separation require a frequency management arrangement which may be either an allocation of specific frequencies for each site or testing to determine that freedom from interference exists. Allocation plans or interference test reports shall be signed by the parties involved and provided to AMA Headquarters. Documents of agreement and reports may exist between (1) two or more AMA Chartered Clubs, (2) AMA clubs and individual AMA members not associated with AMA Clubs, or (3) two or more individual AMA members.

6) For Combat, distance between combat engagement line and spectator line will be 500 feet per cubic inch of engine displacement. (Example: .40 engine = 200 feet.); electric motors will be based on equivalent combustion engine size. Additional safety requirements will be per the R/C Combat section of the current Competition Regulations.

7) At air shows or model flying demonstrations a single straight line must be established, one side of which is for flying, with the other side for spectators.

8) With the exception of events flown under AMA Competition rules, after launch, except for pilots or helpers being used, no powered model may be flown closer than 25 feet to any person.

9) Under no circumstances may a pilot or other person touch a powered model in flight.

Organized R/C Racing Event

10) An R/C racing event, whether or not an AMA Rule Book event, is one in which model aircraft compete in flight over a prescribed course with the objective of finishing the course faster to determine the winner.

A. In every organized racing event in which contestants, callers and officials are on the course:

1. All officials, callers and contestants must properly wear helmets, which are OSHA, DOT, ANSI, SNELL or NOCSAE approved or comparable standard while on the racecourse.

2. All officials will be off the course except for the starter and their assistant.

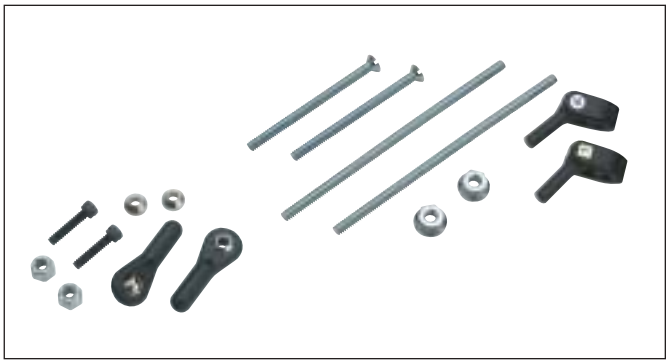
3."On the course" is defined to mean any area beyond the pilot/staging area where actual flying takes place.

B. I will not fly my model aircraft in any organized racing event which does not comply with paragraph A above or which allows models over 20 pounds unless that competition event is AMA sanctioned.

C. Distance from the pylon to the nearest spectator (line) will be in accordance with the current Competition Regulations under the R/C Pylon Racing section for the specific event pending two or three pylon course layout.

11) R/C Night flying is limited to low performance models (less than 100 mph). The models must be equipped with a lighting system that clearly defines the aircraft's attitude at all times.

Hangar 9 accessories are designed specifically to meet the demands of top-level models such as the Hangar 9 Ultimate.



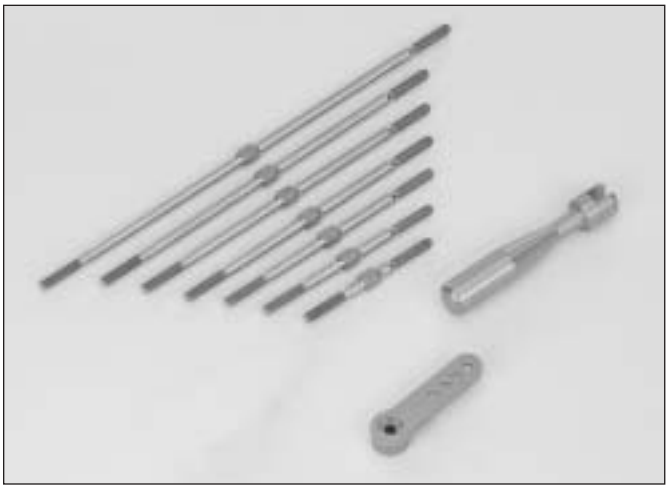
Giant Scale Precision Control Horns (HAN3614, HAN3615)

HD Ball Links (HAN3616, HAN3617, HAN3618)

- Strong and durable
- Ideal for hi stress giant scale models

TITANIUM PRO-LINKS (HAN3550-HAN3558)

With their size and weight, giant-scale aircraft place higher demands on their control systems. This is especially true for giant-scale aerobatic airplanes. Hangar 9's Titanium Pro-Links offer the ultimate in strength and security with the added bonus of ease of adjustability and ultra-light weight.



Double HD Ball Links (HAN3619)

Perfect for multi-servo installations

Pro-Lite Wheels (HAN300-HAN309)

Hangar 9's new Pro-Lite Wheels are the perfect blend of scale realism and weight savings. Each wheel features a skinned foam tire that has the appearance or real rubber but a fraction of the weight. The large hubs on which the tires come mounted are exceptionally durable and lightweight as well. Pro-Lite wheels are available in 1" to 4" sizes.

HANGAR 9®

HORIZON HOBBY

4105 Fieldstone Road
Champaign, Illinois 61822
(217) 355-9511
www.horizonhobby.com

5833