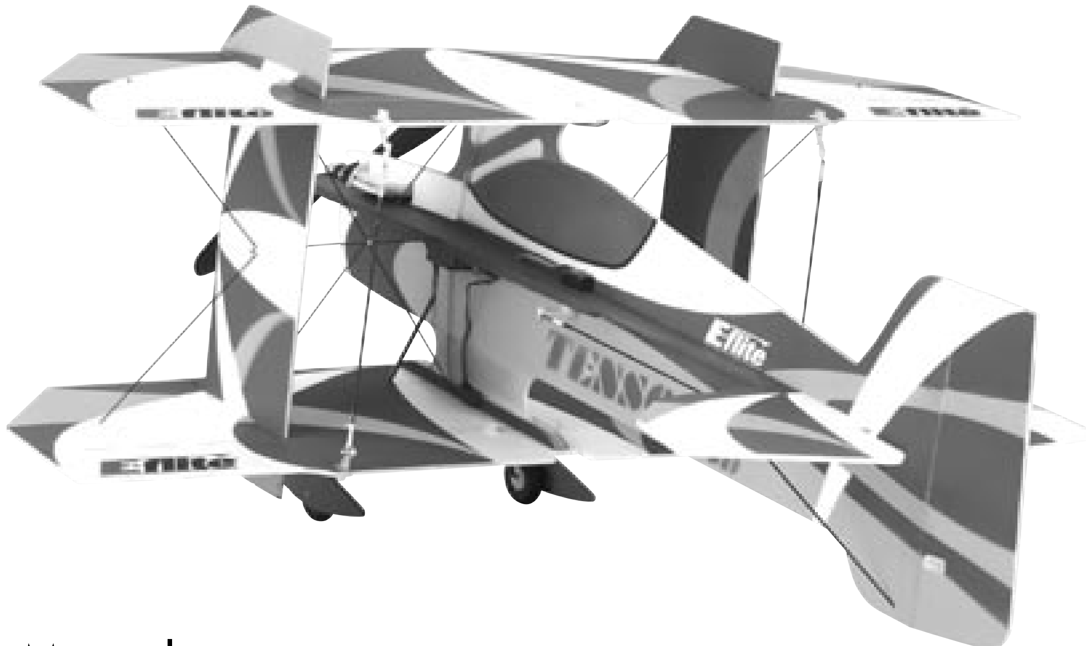
Tensor 4D



Assembly Manual

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Introduction

A true breakthrough in electric flight, the Tensor 4D lightweight design takes extreme 3D aerobatics to a new level. The Tensor is designed by Aerodynamicist George Hicks, a top-level Unlimited Aerobatic ace. The Tensor features unique side force generators for maximum yaw authority and knife–edge flight, light wing loading, carbon fiber wing and tail support for reinforcement and added strength, and precision laser cut pre-painted flat foam construction.

Specifications

Wingspan: 27 in (685 mm)
Length: 30 in (760 mm)
Wing Area: 393 sq in (25 sq dm)
Weight w/o Battery: 8 oz (230 g)
Weight w/Battery: 9.5 oz (270 g)

Warning

An RC 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.

Additional Required Equipment

Recommended JR® Systems

Servos: JR 241 Sub-micro servo (3)
Receiver: JR R610M 6-channel micro FM Rx or R610UL
Radio: JR 4-channel system

Battery and Speed Control Requirements

Li-Po Battery: 7.4V 860 2-Cell
Speed Control: 10 amp brushless

Additional Tools and Adhesives

Tools

Square
Hobby knife
Ruler
T-pin
Razor saw
Drill bit: 1/16", 1/8"
Drill
Small Phillips screwdriver

Motor/Gearbox

E-flite™ Park 370 Outrunner, 1080KV
Propeller: 10x4.7

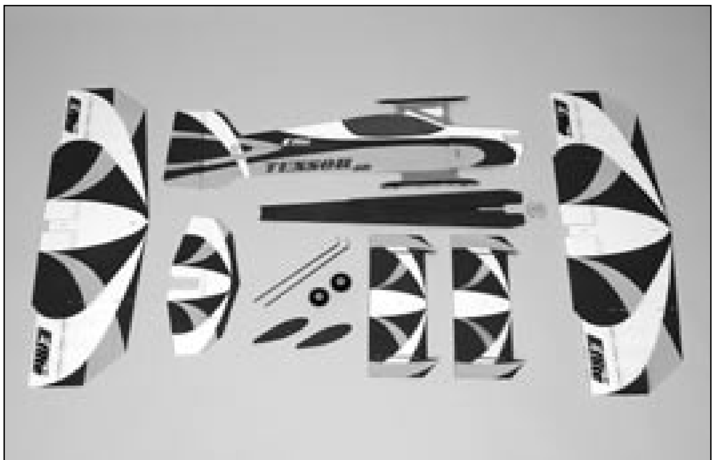
Adhesives

Foam-safe CA
Servo tape
Thin CA

Contents of Kit/Parts Layout

Large Replacement Parts:

EFL2101	Wing Set w/Struts
EFL2102	Vertical Fuselage w/Rudder
EFL2103	Horizontal Fuselage
EFL2104	Tail Assembly
EFL2105	Wheel Pants
EFL2106	Firewall Mount w/Hardware
EFL2110	Landing Gear



Small Replacement Parts:

EFL2108	Carbon Fiber Wing Supports
EFL2109	Pushrods and Control Rods
EFL2107	Nylon String (120")
EFLA200	Micro Control Horns
EFLA201	Micro Pushrod Keepers
EFLA202	Micro Control Connectors
EFLA221	Foam Park Wheels, 1.5"
EFLA2086	Hook and Loop Tape

Required Items

EFLP1047	10x4.7 Slow Flyer Propeller (2)
JRP4487	Quattro UL, R610UL, 2-S241
JRPS241	S241 Sub-micro Servo
EFLB1000	7.4v 860mAh 2-cell Li-Po, JST
THP13602SJ	7.4v 860mAh 2-cell Li-Po, JST
EFLM1200	Park 370 Outrunner, 1080KV
CSEPHX10L	Phoenix 10-Amp Brushless ESC

Other E-flite™ Accessories

EFLM1205	Park 370 Outrunner, 1360KV
EFLC3005	Celectra™ 1- to 3-cell Li-Po Charger
EFLM110	Power Meter
EFLA208	Foam CA 1 oz/ Activator 2 oz pack

Before Starting Assembly

Before beginning the assembly of your Tensor 4D, 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 the place of purchase.

Using the Manual

This manual is divided into sections to help make assembly easier to understand, and to provide breaks between each major section.

Remember to 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 component parts damage 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 resulting from the use of the final assembled product. By the act of using the assembled product, the user accepts all resulting liability.

Please note that once assembly of the model has been started, you must contact Horizon Hobby, Inc. directly regarding any warranty question. 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, Inc.
4105 Fieldstone Road
Champaign, Illinois 61822
(877) 504-0233
www.horizonhobby.com

Fuselage Assembly

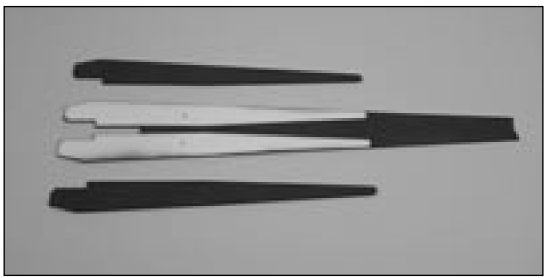
Required Parts

Vertical fuselage	Horizontal fuselage
Horizontal fuselage support (2)	Elevator/stabilizer
Carbon elevator joiner brace	

Required Tools and Adhesives

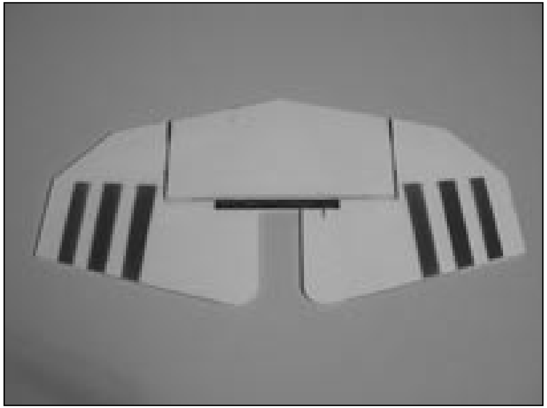
Foam-safe CA	Square

❍ 1. Carefully remove the horizontal fuselage supports from the horizontal fuselage.

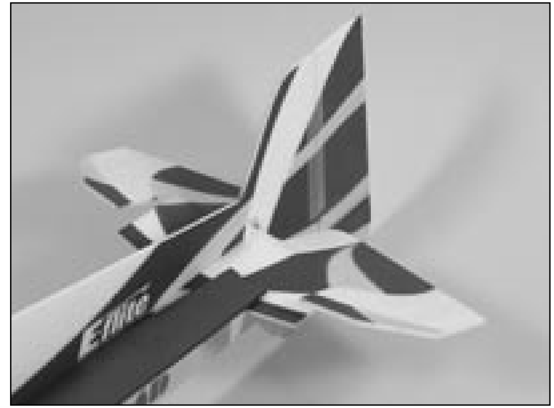


❍ 2. Slide the horizontal fuselage partially into position. The unpainted side will face the bottom of the fuselage.

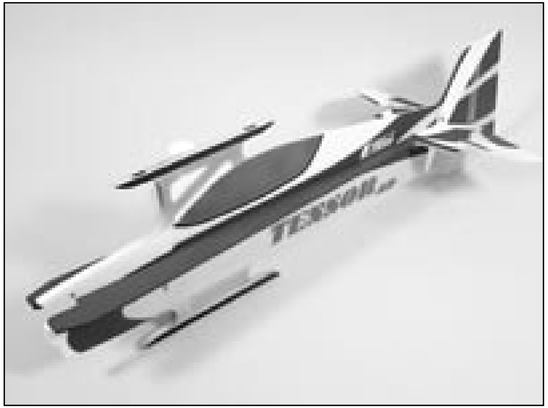
❍ 3. Use foam-safe CA to attach the carbon stabilizer joiner brace to the bottom of the elevator.



❍ 4. Slide the elevator/stabilizer assembly into position.

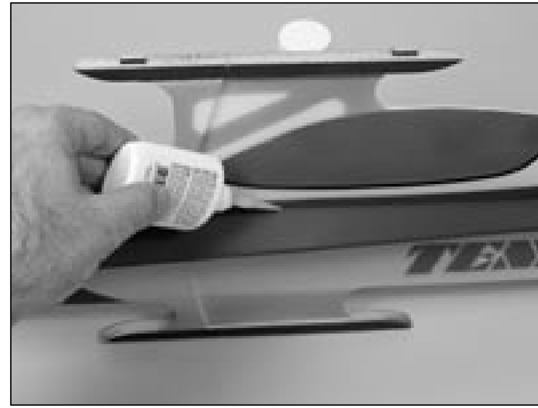


❍ 5. Slide the horizontal fuselage fully forward in the fuselage. Center it in the main fuselage, making sure the notch at the rear fits with the stabilizer.



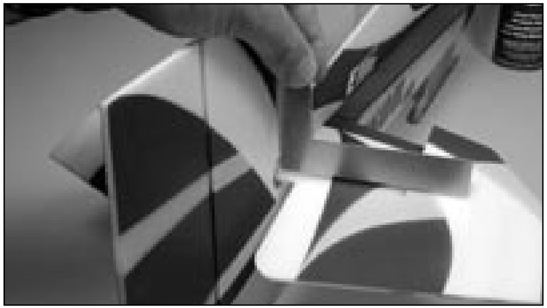
Note: There are small notches along the center of the horizontal fuselage to aid in alignment.

❍ 6. Use foam-safe CA to glue the horizontal fuselage to the vertical fuselage.



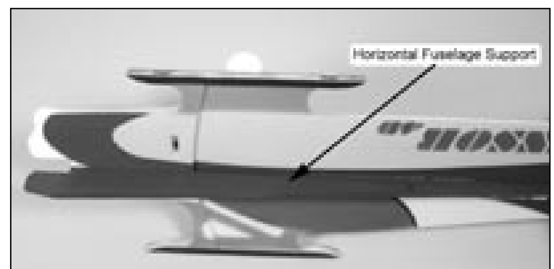
Note: Do not use accelerator unless you are sure it will not harm the foam or paint on your model.

❍ 7. Slide the stabilizer forward against the horizontal fuselage. Use a square to check the alignment to the fuselage.



❍ 8. Use foam-safe CA to glue the stabilizer into position.

❍ 9. Use foam-safe CA to glue the horizontal fuselage supports into position on the bottom of the fuselage support.



Radio Installation

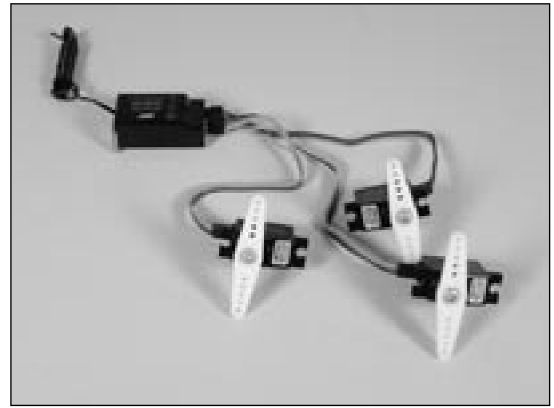
Required Parts

Fuselage assembly
Micro control connector (2)
Control connector backplate (2)
2mm x 4mm screw (2)
Micro control horn (2)
Micro control horn backplate (2)
.065" x 16" carbon pushrod (2)
1/32" x 2" pushrod end (4)
Micro pushrod keeper (2)
String

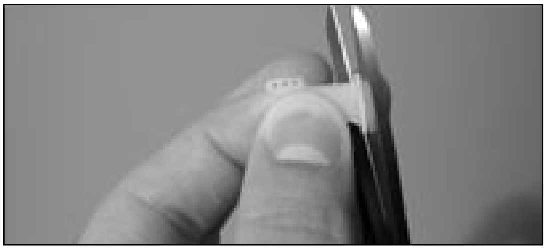
Required Tools and Adhesives

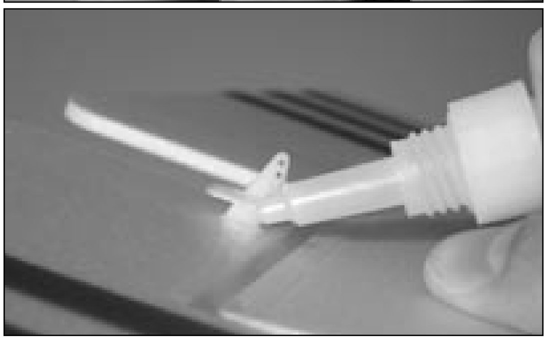
Foam-safe CA
Razor saw
Servo tape

❍ 1. Plug in the aileron, elevator and rudder servos to the receiver following the instructions from your radio system. Turn on the radio and center the trims on the transmitter. Install long servo arms on the servos.

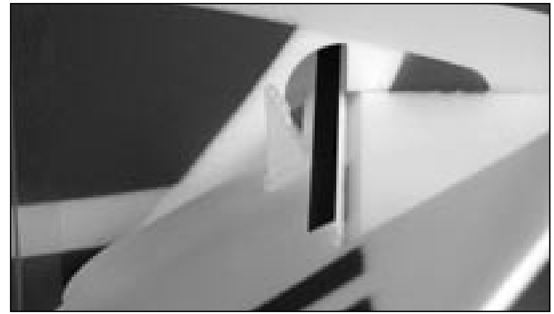


Note: The control horns can be modified to greatly increase surface throws. Remove the back flange of the horn using scissors. Install the horn by sliding the horn through the control surface. Slide the backplate onto the horn and use foam-safe CA to glue the backplate into position.

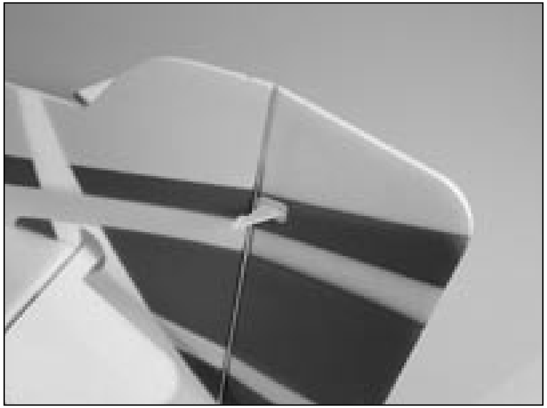




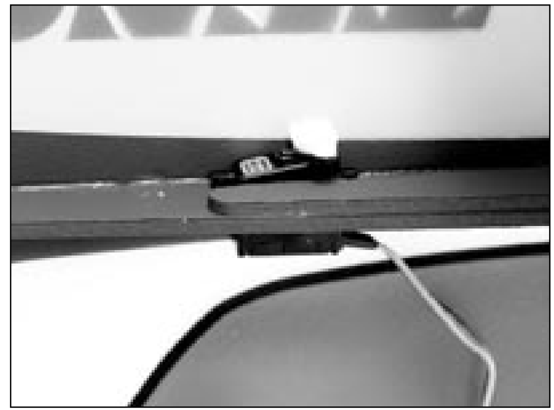
❍ 2. Attach the micro control horn to the elevator using the micro control horn backplate. Place a few drops of foam-safe CA on the backplate to ensure its security.



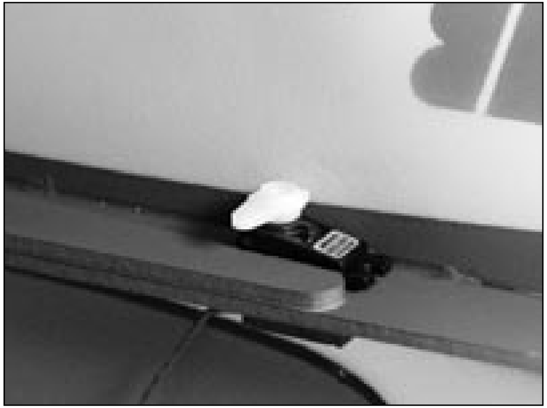
❍ 3. Install the rudder control horn, making sure it is on the opposite side of the elevator horn.



❍ 4. Trim one of the servo arms from the elevator servo. Cut a hole in the horizontal fuselage support to fit your servo. The servo must rest flush with the support. Use double-sided tape or foam-safe CA to attach the servo to the fuselage support. The arm faces the front of the fuselage, and the aft edge of the servo aligns with the aft edge of the fuselage spine support.

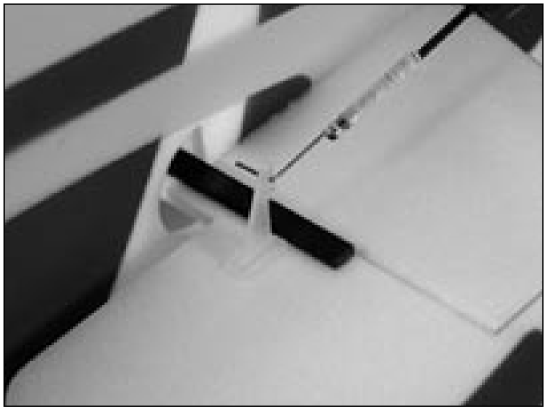


❍ 5. Repeat Step 4 for the rudder servo.

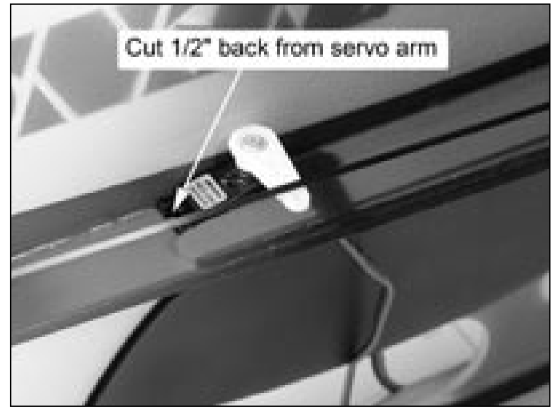


❍ 6. Prepare one of the .065" x 16" carbon pushrods by attaching one of the 1/32" x 2" pushrod ends using 10" of string and thin CA. Make a 90-degree bend 1/4" from the end of the pushrod end.

❍ 7. Pass the bend in the pushrod through on of the holes in the elevator control horn. Use the outer hole for minimum throw and the inner hole for maximum throw.



❍ 8. Tape the elevator so it will remain centered. Measure back 1/2" from the elevator servo arm on the pushrod. Cut the pushrod at this location using a razor saw.

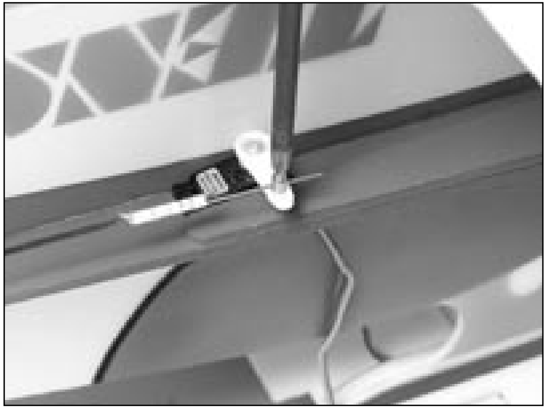


❍ 9. Attach another 1/32" x 2" pushrod end to the pushrod.

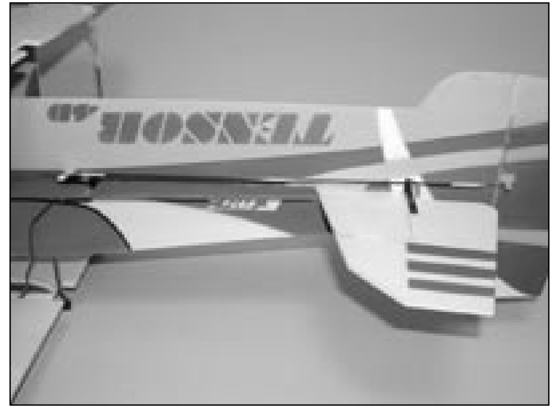
❍ 10. Install a micro control connector and connector backplate to the servo arm.

❍ 11. Attach the L-bend to the control horn using a micro pushrod keeper.

❍ 12. Slide the pushrod end through the micro connector. Center the elevator and secure the pushrod using a 2mm x 4mm screw.



❍ 13. Repeat Steps 7 through 13 to assemble and install the rudder pushrod.



Wing Installation

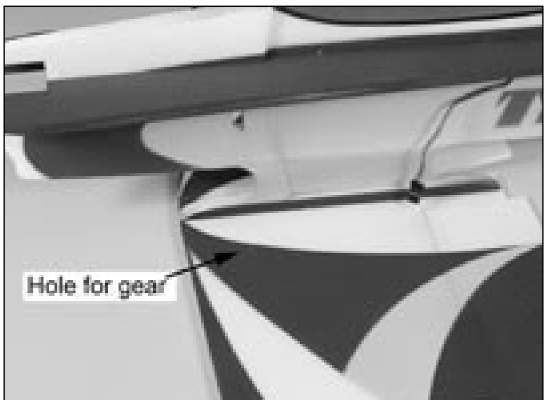
Required Parts

Fuselage Assembly	Lower wing
Side force generator (2)	

Required Tools and Adhesives

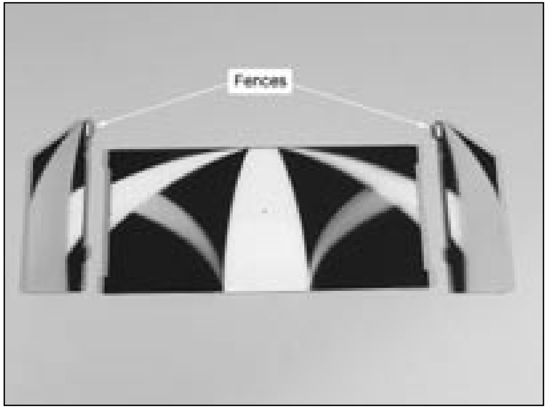
Foam-safe CA	Hobby knife
Square	

❍ 1. Test fit the lower wing to the fuselage. The lower wing has the holes towards the leading edge for the landing gear wires.

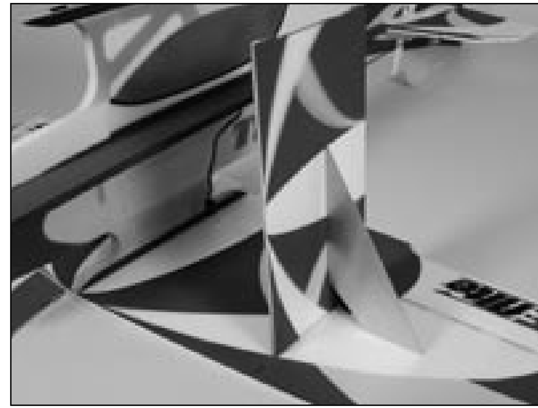


❍ 2. Carefully check to make sure the lower wing is square to the fuselage. Use foam-safe CA to glue the lower wing to the fuselage.

❍ 3. Locate the side force generators. Use a sharp hobby knife to remove the upper and lower fences from the main section.



❍ 4. Position the side force generator in the holes closest to the trailing edge of the bottom wing. Use a square and foam-safe CA to glue the side force generator into position.



❍ 5. Repeat Steps 3 and 4 for the remaining side force generator.

❍ 6. Place the top wing onto a flat surface. Position the side force generators and fuselage onto the wing. Hold the wing flat while gluing the fuselage and side force generators to the wing.

Note: It is recommended to use a square to check the side force generator alignment to the top wing.

Note: DO NOT glue the upper and lower fences at this time.

Carbon Rod Installation

Required Parts

Assembled airframe

.046" x $11^1/_4$″ carbon rod (4)

.046" x $6^1/_4$" carbon rod (6)

Required Tools and Adhesives

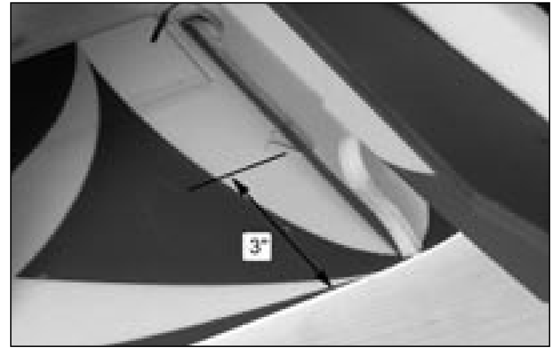
Foam-safe CA

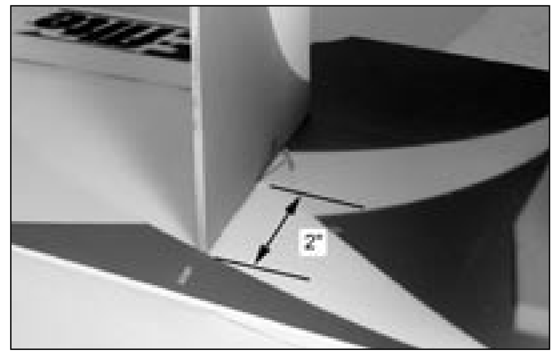
Thin CA

T-Pin

Note: You may want to locate a thin piece of depron or other foam for the next section. A thin board will work too. This is necessary to keep the wing as flat as possible to keep from inducing any twist in the wing, which will greatly affect the performance of your Tensor.

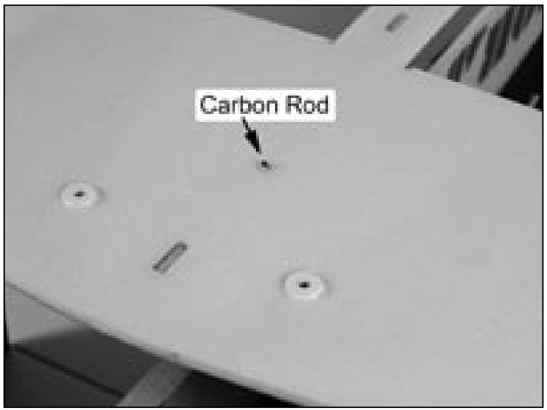
❍ 1. Use a T-pin to make small holes where the cross braces will be installed. These locations are located 3″ back on the top and bottom of the wing supports at the fuselage, and 2″ back for the side force generators.





Hint: If you look carefully there are notches at the locations mentioned in Step 1.

❍ 2. Slide a .046" x $11^1/_4$" carbon rod from the lower fuselage to the upper side force generator. Leave at least 1/16" of the rod exposed at both ends. Glue only the rod at the fuselage. Apply foam-safe CA to the rod both at the inside and outside in order to capture the rod in position.



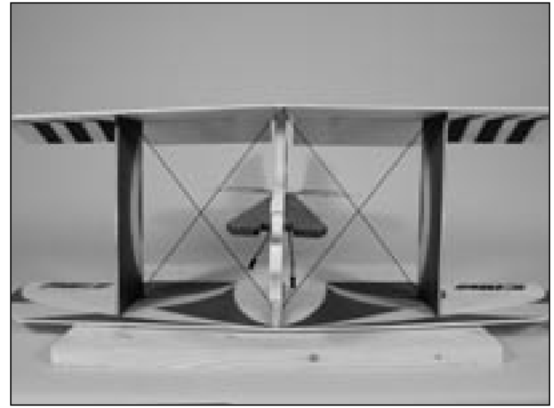
❍ 3. Place the top wing on a surface that will allow the wing panel to lie perfectly flat. Apply glue to the inside edge of the rod. Once the glue fully cures carefully lift the airframe and apply CA to the top of the rod.

❍ 4. Repeat Steps 2 and 3 for the opposite side.

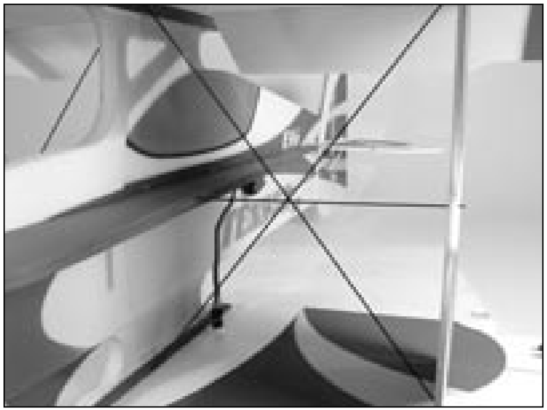
❍ 5. Slide a .046" x 11 1/4" carbon rod from the upper fuselage to the lower side force generator. Leave at least 1/16" of the rod exposed at both ends. Glue only the rod at the fuselage. Apply foam-safe CA to the rod both at the inside and outside in order to capture the rod in position.

❍ 6. Place the bottom wing on a surface that will allow the wing panel to lie perfectly flat. Apply glue to the inside edge of the rod. Once the glue fully cures carefully lift the airframe and apply CA to the top of the rod.

❍ 7. Repeat Steps 5 and 6 to complete the cross bracing.

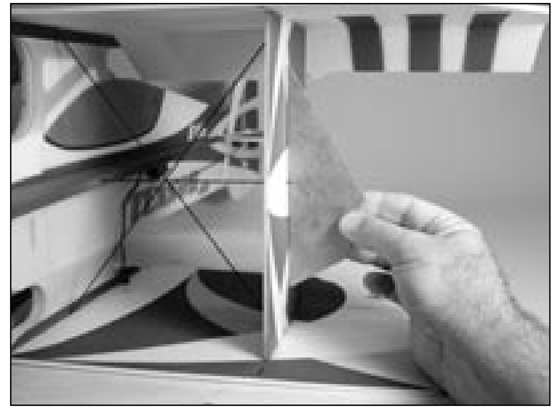


❍ 8. Install one of the .046" x $6^{1}/_{4}$" rods through the hole in the center of the side force generator and into the fuselage spine. Leave at least 1/16" of the rod exposed on the outside of the side force generator. Glue the rod only to the fuselage spine.



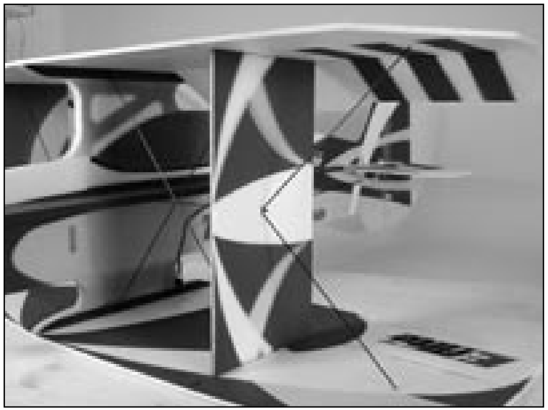
Note: There is a small notch in the spine for the location for the carbon rod.

❍ 9. Use a straight edge to make sure the side force generator is not bent in or out on the wing. Glue both sides of the rod to the side force generator.



❍ 10. Repeat Steps 8 and 9 for the remaining center rod.

❍ 11. Locate two .046" x 6$^1/_4$" carbon rods for use as the tip bracing. Glue the braces at the side force generator first, and then check the wing on a flat surface before gluing the brace to the upper and lower wings. Repeat for both left and right sides.



❍ 12. Cut a 10" piece of string. Wrap the string around the junction of the inner braces. Use thin CA to secure the string to the braces.

Aileron Servo Installation

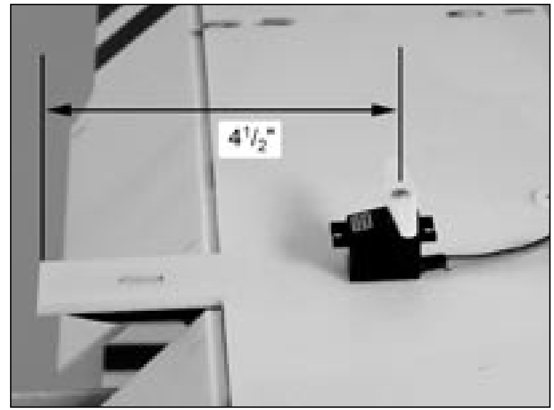
Required Parts

Assembled airframe
Micro control connector (4)
Control connector backplate (4)
2mm x 4mm screw (4)
Micro control horn (6)
Micro control horn backplate (6)
.065" x 7" carbon pushrod (2)
1/32" x 2" pushrod end (4)
1/32" x $3^1/_8$" pushrod (2)
Micro pushrod keeper (2)

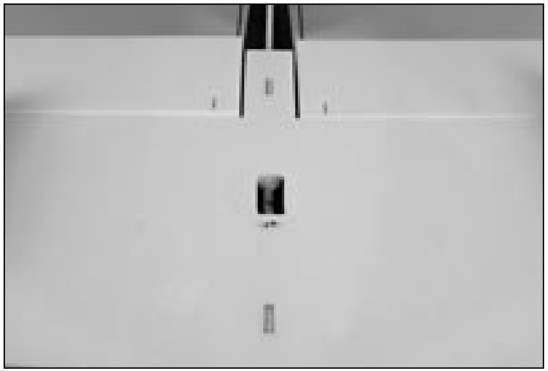
Required Tools and Adhesives

Foam-safe CA	T-Pin
Drill	1/16" drill bit
Razor saw	

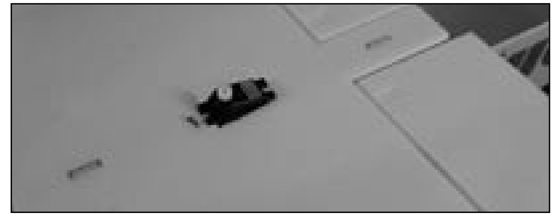
❍ 1. Position the aileron servo on the bottom of the bottom wing so the output shaft is $4^1/_2$" forward of the trailing edge. Mark the position of the front and rear of the servo onto the wing using a T-pin.



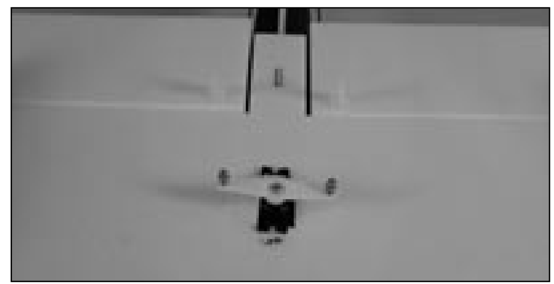
❍ 2. Cut a hole in the bottom wing and through the vertical fuselage that will fit your particular servo. Make sure the hole is centered in the wing.



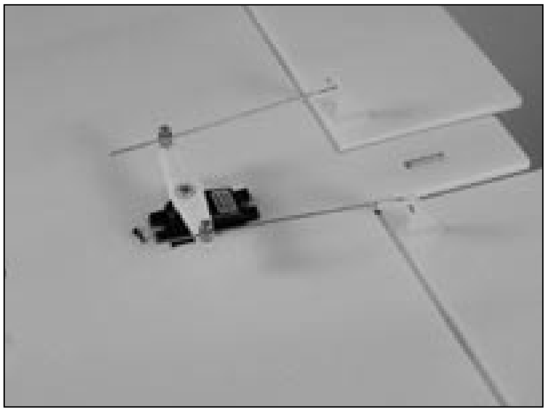
❍ 3. Install the aileron servo using foam-safe CA. Make sure to glue the servo to both the wing and the fuselage.



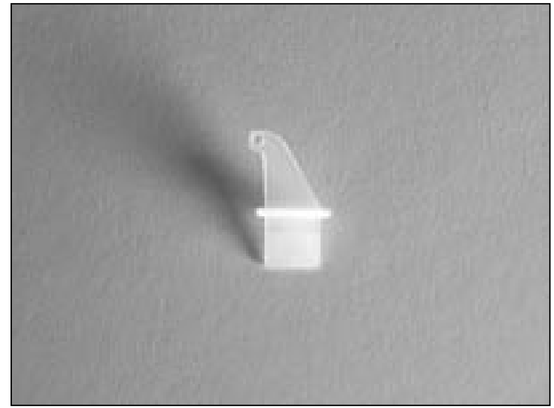
❍ 4. Install the aileron control horns and micro connectors. Use a servo arm that is the same width as the spacing between the control horns.



❍ 5. Build and install the linkages using two 1/32" x 3 1/8" pushrods. Secure the linkages to the control horn using two micro pushrod keepers. Center the ailerons and aileron servo. Use 2mm x 4mm screws to complete the aileron linkage installation.

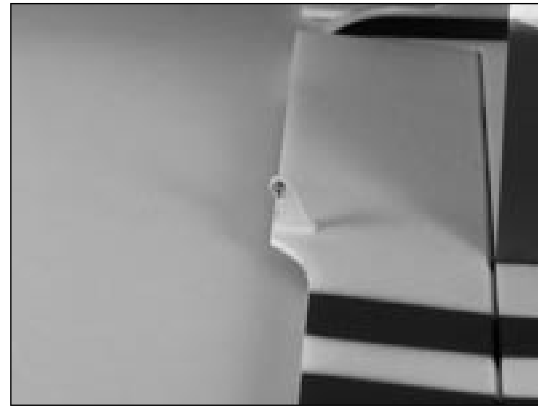


❍ 6. Trim the remaining four control horns as shown. Enlarge the hole in two (2) of the control horns using a 1/16" drill bit.

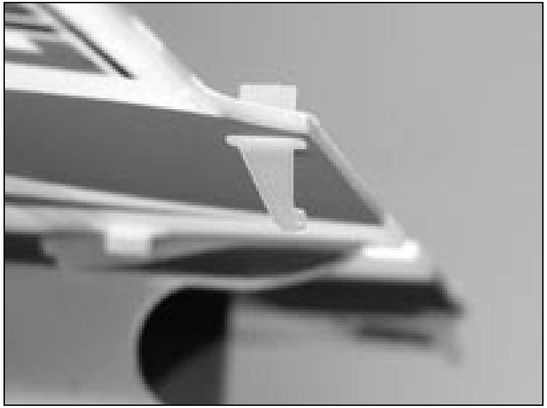


❍ 7. Install the remaining two micro connectors in the drilled out horns. Make sure to install the connectors opposite each other as shown.

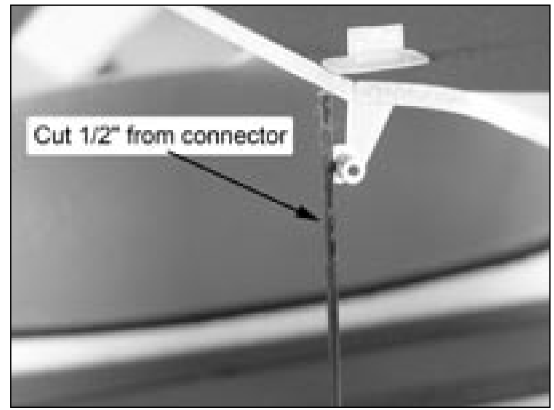
❍ 8. Install a horn from the previous step in the upper wing. The connector will face outward, allowing access to the screw. The horn will face away from the wing as shown.



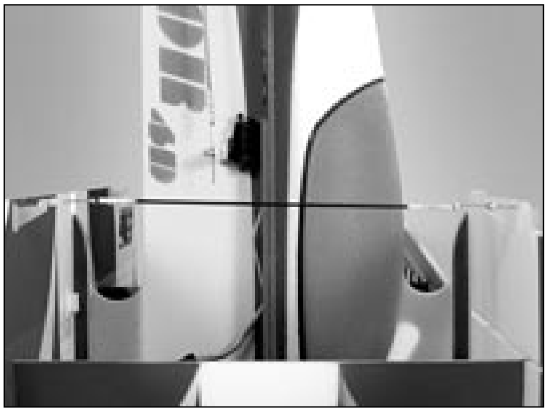
❍ 9. Install a control horn in the bottom aileron.



❍ 10. Assemble an aileron connecting pushrod using .065" x 7" carbon rod, 1/32" x 2" pushrod end and 10" of string. Bend the rod at a 90-degree angle and attach it to the bottom aileron control horn. With the ailerons centered, measure and mark the pushrod 1/2" below the connector on the top aileron.



❍ 11. Cut the carbon at the rod at the mark made in the previous step using a razor saw. Finish the assembly of the pushrod using a 1/32" x 2" pushrod end and 10" of string. Install the pushrod using a micro pushrod keeper and a 2mm x 4mm screw.



❍ 12. Repeat Steps 8 through 11 to assemble and install the remaining aileron connecting pushrod.

Installing the Electronics

Required Parts

Assembled airframe	Plywood motor mount
4-40 x 3/8" socket screw (2)	
4-40 locknut (2)	Hook and loop tape

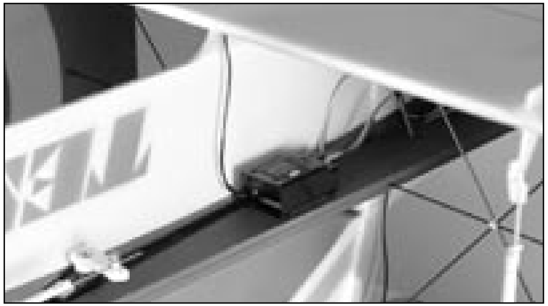
Required Tools and Adhesives

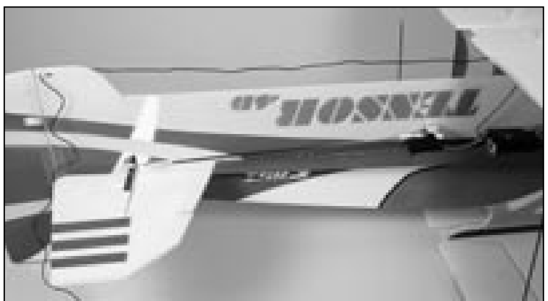
Foam-safe CA	1/8" drill bit
Drill	Receiver
Speed control	Motor

❍ 1. Locate the plywood motor mount. Attach your particular motor at this time using two 4-40 x 3/8” socket screws and two 4-40 locknuts. To save weight use wood screws, making sure they are secure in the mount by adding a drop of thin CA when the protrude from the mount.

❍ 2. Slide the motor into position in the fuselage. Glue the plywood mount to the fuselage using foam-safe CA. Trim the fuselage as necessary to clear the motor and wiring to the motor.

❍ 3. Mount the receiver in an inconspicuous location on the fuselage spine using hook and loop or double-sided tape. Plug the elevator, rudder and aileron servos into the receiver. Route the antenna wire to the bottom of the fin.





❍ 4. Solder any necessary connectors to your speed control. Cut a small hole in the fuselage spine to pass the battery lead through. Connect the speed control to the receiver and motor. Attach the speed control to the fuselage spine using hook and loop or double-sided tape. Tie any loose wires so there is no chance they can enter into the spinning propeller.

❍ 5. Use hook and loop tape to secure the battery directly to the side of the fuselage behind the motor positioned to obtain the correct CG. An alternate method is shown below. Trim a section of the fuselage so you can slide the battery in place, securing with hook and loop.

❍ 6. Set up the operation of the motor using the instructions included with your particular speed control at this time.

❍ 7. Attach the propeller to the motor, after making sure the battery has been unplugged.

Landing Gear Installation

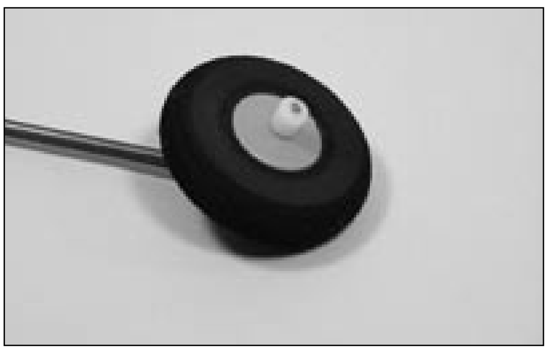
Required Parts

Assembled airframe
$1^{1}/_{2}$" wheel (2)
Wheel pant (2)
Landing gear (2)
Wheel stopper (2)

Required Tools and Adhesives

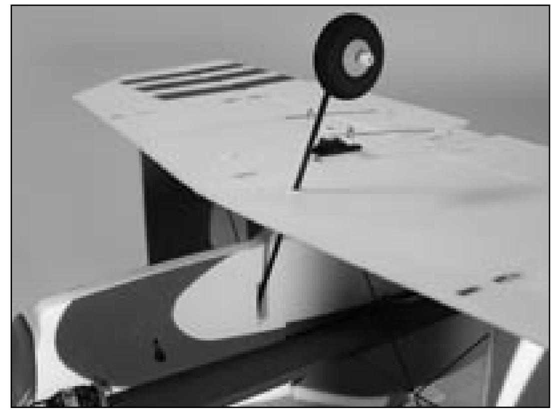
Foam-safe CA

❍ 1. Place the wheels on the landing gear. Check that they can roll freely. Enlarge the hole in the wheel if necessary. Use a wheel stopper and foam-safe CA to retain the wheel.



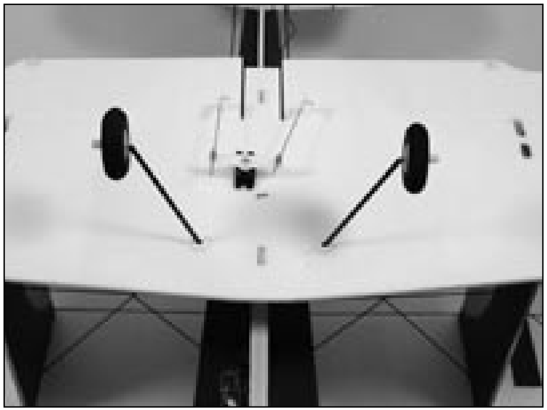
Note: Be very careful not to get CA onto the wheel, preventing it from rolling.

❍ 2. Slide the gear into position, but do not glue it yet. The end of the gear will rest in the hole on the fuselage spine support.



❍ 3. Repeat Steps 1 and 2 for the remaining landing gear and wheel.

❍ 4. Position the wheels so they are parallel to the fuselage centerline. Check to make sure the installation of the landing gear is not deforming the bottom wing. Use foam-safe CA to glue the landing gear to the wing, vertical fuselage and horizontal fuselage support.



❍ 5. Attach the wheel pants by gluing them to the wheel stoppers.

Final Assembly

Required Parts

Assembled airframe
.065" x 6" carbon rod (2)
Upper and lower side force generator (2)

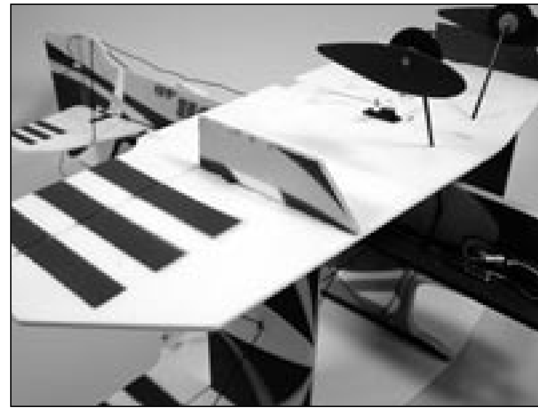
Required Tools and Adhesives

Foam-safe CA

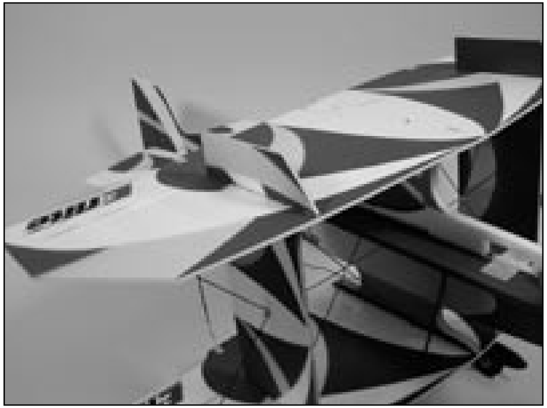
❍ 1. Locate a .065" x 6" carbon rod. Position the rod from the tip of the stabilizer to the bottom of the fin. Use foam-safe CA to glue the rod into position.

❍ 2. Repeat step 1 for the remaining carbon rod.

❍ 3. While the plane is upside down, install the lower fences onto the bottom wing.



❍ 4. Turn the plane over so it is resting on its wheels. Install the upper fences using foam-safe CA.



Control Throws

Aileron:	30 degrees Up (Use 40% expo)	30 degrees Down
Elevator:	60 degrees Up (Use 60% expo)	60 degrees Down
Rudder:	40 degrees Right (Use 50% expo)	40 degrees Left

Center of Gravity

An important part of preparing the aircraft for flight is properly balancing the model.

Caution: Do not inadvertently skip this step!

The recommended Center of Gravity (CG) location for the Tensor™ is $2^1/_4$"—$2^1/_2$" (57mm—63.5mm) behind the leading edge of the top wing against the fuselage. If necessary, move the battery pack towards the nose or the tail until the correct balance is achieved.

General Set-up Tips for 3D Flight

People often spend a tremendous amount of time constructing a perfectly straight airplane only to neglect the radio installation. The control system is arguably of equal importance to actual construction and must be given adequate attention to ensure that the potential of the airplane is realized.

Since the purpose of the Tensor is 3D/Artistic Aerobatic flying, take a moment to think about what is actually necessary for successful 3D flight. The first obvious answer is static thrust. In order to hover, the minimum amount of thrust necessary is equal to the total weight of the airplane. In reality we need to have some excess thrust to maneuver and accelerate. This is the primary reason that the total weight of the airplane must be kept to a minimum. The Tensor is designed to have a flying weight under 10 ounces. The best way to test to make sure you have adequate thrust for hovering flight is to hold the airplane vertically and advance the throttle to full power. The static thrust should be enough to make the airplane accelerate vertically from a standstill.

Many people also consider the proverbial "aft" center of gravity (CG) to be crucial to hovering success. Through much experimentation on many types of models, we have found that neither a very forward or very aft CG is beneficial to hovering flight. In fact, given sufficient control surface movement, softened correctly with exponential throws, one can hover controllably over a large range of CG positions. The center of gravity is even more critical on the Tensor because it is capable of producing substantial force (lift) both up-and-down and side-to-side. In other words a single CG position must provide both longitudinal and directional stability.

This brings us to the most important aspect of 3D setup—control surface deflection. Do you need large amounts of deflection to hover? The truth is you do not. During the perfect hover or torque roll you barely move the surfaces off their neutral position. It is not until you get the airplane in an attitude far enough from vertical that you need to delve into your large reserves of control surface throw and excess power. You will find that having 45–60 degrees of throw is very beneficial to your success in 3D flight. Typically, the most throw you can mechanically achieve is what you should use. Set up the airplane such that maximum throw is obtained by placing the pushrod the farthest hole out on the servo and the hole closest to the control surface on the control horn. While this is not standard or recommended practice on a larger airplane because of the potential of flutter, this type of setup works quite well on the aerobatic indoor electric models.

Large amounts of throw tend to make the airplane feel very sensitive around neutral. Because of this, it is highly recommended that you use a radio with dual rates that is capable of exponential throws. A good way to correctly set the amount of exponential for the 3D-rate is to find a low-rate setting that feels comfortable in normal flight. Once you've done this for the aileron, elevator, and rudder, dial in enough exponential to make the low-rate setting and 3D-rate setting feel the same for the first 1/3 of the stick travel. If you have a computer radio that displays the graph of stick position vs. servo output, you can easily set the correct amount of exponential by making the slopes of these graphs identical for the first 1/3 of stick movement as shown on the following page.

Trimming and Flying the Tensor 4D

Now that the airplane mechanical set-up is correct, it is time to fine-tune the set-up in the air. Start by flying the airplane on low rates. If you have triple rates, set the mid-rate in between the high and low rates. Once you get comfortable with the airplane and tune the exponential setting, you will be able to fly it all the time on the 3D rates.

One will find the propeller effects (such as torque, spiral slipstream, P-factor, gyroscopic procession and prop normal force) often dominate the stability and control of the smaller indoor airplanes. Consequently, the use of smaller diameter/lower-pitch propellers tends to reduce the adverse effects on the airplane's longitudinal and directional stability. The smaller diameter will reduce static thrust, however, lower pitch increases static thrust. With this in mind, we quickly see there is a compromise between the precision and 3D propeller selection. Note that the Tensor was designed to perform well on a 10 x 4.7 propeller. While most airplanes need right thrust because of an asymmetric vertical tail configuration, the Tensor has nearly equal vertical tail area above and below the thrustline. As a result the Tensor needs no side thrust to fly properly.

Rolling maneuvers are done with relative ease with the Tensor. What you will find is that very little if any rudder is needed during the knife-edge portion of the roll to keep the nose from falling. This is because the side force generators are literally holding the nose up for you. This makes it easy to perform normal aileron rolls, slow rolls, point rolls, rolling circles and rolling loops while using very little rudder input.

Knife-edge flight is also a strong point of the Tensor. The side force generators allow it to fly very slowly in knife-edge. The Tensor does have both roll and pitch coupling that should be mixed out with a computer radio. At the center of gravity position specified in these instructions, the Tensor will tend to pitch toward the landing gear both in left and right rudder knife-edge flight. Simply use a linear rudder to elevator mix to reduce this pitching tendency. Left and right rudder knife-edges will require slightly different levels of mixing because of P-factor. Typically right rudder knife-edge flight requires less up elevator mix that left rudder knife-edge. The Tensor also has some proverse roll coupling with rudder. This means that the airplane will tend to roll in the same direction as the rudder input. Use a linear rudder to aileron mix to reduce this rolling tendency. The fences that extend the side force generators through the wing are in place to reduce and linearize the Tensor's roll coupling. At the bottom of a tight knife-edge loop one will notice that the coupling will change direction if the sideslip angle gets too large. This roll reversal is gradual enough that the pilot can overcome it by giving aileron in the same direction as rudder. This little trick makes performing knife edge loops much easier than trying to use a nonlinear mix to handle the situation.

The Tensor is especially good at the 3D type maneuvers such as Torque Rolls, Elevators / Harriers, and High-Alpha Rolls. The large amount of aileron area in the propeller slipstream actually make it possible to perform anti-torque rolls (spinning to the right while hovering) Because of its ultra-light wing loading the Tensor is truly meant to be flown indoors in a windless environment but will easily handle 5-10mph wind conditions outside. The Tensor seems to fly best with a 7.2V Li-Poly battery indoors and a 12V Li-poly battery outdoors. Many of the top-level pilots who have flown this model say that it has new maneuvers hidden inside it…perhaps you'll be the one to discover them.

Basic Guide for Learning to Fly 3D Maneuvers

The Tensor is quite capable of performing a wide range of 3D maneuvers, but the ultimate goal is to make the pilot capable of performing them as well…let's start with some thoughts about torque rolls and hovering in general.

How does one go about learning how to torque roll? The best way is to practice on a simulator until you can literally do the maneuver without needing to think about the inputs. The skill involved is nothing more than a muscle memory response to what you see the airplane doing.

Is the simulator realistic? Probably not, but regardless of its accuracy it will get your eyes and hands accustomed to the proper movements required to perform the maneuver. The simulator will help you get over the "mechanics" of the maneuver so you will not have to think about which direction to move the sticks when faced with the real thing.

How much should you have to practice? If you are serious about learning how to hover or torque roll, work on the simulator 30 minutes to an hour each night for a month. Evaluate your progress after this amount of time. Chances are you will have become bored with the simulator and are ready to tackle the real airplane with confidence, but do not be surprised or discouraged if it takes three months of dedicated practice. Remember that there is nothing super-human about hovering. Anyone who is willing to put in the practice time can learn to do this maneuver. Of course you can be a purest and learn to hover solely with the real airplane, but it will take longer because you physically cannot get the practice time with a model that you can on the simulator. Keep in mind that your simulator practice must be supplemented with actual flying because you need to learn how to react when the consequence of a mistake is a crash. The good thing about the Tensor is you can typically pick it up after a mishap and fly again immediately. Nerves can play a big part in hovering success, but you will find the better you get at the simulator, the more confidence you will have with the real airplane and the nerves will eventually subside, thus freeing your mind to concentrate on flying the model. It often helps to have someone show you that your airplane can hover. For some reason this is a huge psychological boost that makes you realize it is not the airplane limiting you. One common mistake people make is hovering too far away from them. The closer you are to the airplane, the better you will be able to control it because you can see it so much better. This is, of course, a double-edged sword because you will also be closer to the ground. Once again the Tensor can handle the abuse thus making it good for training. Eventually you will find that the closer the airplane is to the ground, the less chance it has of getting damaged in a crash because it has less potential energy. This is especially useful if for some reason you have a battery die or the BEC cuts off.

Another common misnomer is that the ailerons do not work while hovering. This could not be further from the truth. If you do not use the ailerons during hovering, you will be at the mercy of the motor's torque and the airplane will continually roll to the left. Two very effective techniques to employ to reduce or stop this rotation is first to counter the left rolling moment with right aileron and also to lean the airplane 5–10 degrees either slightly to the gear or away from it. Leaning the airplane makes it more difficult for the torque of the motor to roll the airplane because the weight and thrust vectors are misaligned. You can also use this mode of flight to move the airplane closer or further away from you. When you start doing this, you will quickly realize that you are starting to perform a very high angle of attack harrier.

With this in mind let's tackle the "Elevator" and "Harrier," which is the second most popular 3D maneuver. A common misconception is that you always fly around with the elevator fully deflected. What you will find is you must continually modulate the elevator to maintain the same angle of attack. This is done by watching the flight path and body angle of the airplane and adjusting the elevator and throttle accordingly. Also you must work to keep the wings level with the ailerons. Many times we hear people say that certain airplanes do not lock into the harrier well. While this may be true, what you will find is most every airplane has a magic angle of attack that minimizes wing-rock, and the pilots whose airplanes appear to be locked into these maneuvers know how to keep their airplane in this sweet spot.

2004 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 or 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.

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 front of the flight line. Intentional flying behind the flight line is prohibited.

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 RC 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.

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