THE RAZOR

Assembly Manual

Wing Span	30"
Wing Area	292 sq.in.
Airfoil	Zagi 9515
Weight	18 oz
Loading	7.4 oz/sq.ft
Radio	3 channel mixing required

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Recommendations

<u>To avoid injury or damage to the motor, do not plug the battery into the speed control until all of the steps have been followed on page 13.</u>

The Razor is not a combat or bungie launch airplane. The design objectives were to make a rugged low cost, light weight electric flying wing.

The target weight for the Razor is 18 oz. The airplane is designed to balance at 8" measured back from the nose. In order to achieve these two objectives, a speed 400 motor, micro servos, and a 500 mAh 7 or 8 cell battery pack must be used. Any modifications, reinforcements or substitutions not described in this manual must be considered carefully to maintain the correct weight and balance. If all of the procedures in this manual are followed, the Razor will not need nose weight.

The recommended charge rate for the N500 A is one amp. This rate will achieve a full charge in 30 minutes. Higher rates will shorten the life of the battery.

Larger radio components are not recommended.

Lightly spray the entire wing with 3M #77 Spray Adhesive before you begin covering. If a substitute adhesive is selected, test spray a patch on the beds before spraying the cores.

The manufacturer did not test any covering materials such as UltraKote, Solarfilm, or any other iron-on materials. If an alternate covering material is chosen, test a patch on the beds first.

Do not cut into any part of the leading edge foam for the radio installation or nose weight.

Tools and materials needed:

3M Super 77 Spray Adhesive
90 degree square
Sanding block
150 to 320 grit sandpaper
X-Acto knife
Round pencil or ball-point pen
Roll of 2 inch fiber filament tape

The Razor Complete Kit Electric Wing Kit contents:

2	Expanded polypropylene wing panels
2	Pre-cut balsa elevons
2	14'' strips of 1'' x 3mil paper backed mylar hinge tape
1	Roll 2.2 mil color poly tape
2	Control horns with 4 screws
2	Threaded 2 X 56 push rods
2	Threaded 2 X 56 clevises
2	Plastic winglets
1	Molded motor mount and battery tray
1	Molded canopy
1	Speed 400 motor and prop
1	The Zagi-20 Speed Eontrol
1	500 mAh battery with Deans plug
2	wire ties to secure motor
2	Velcro strips for canopy and battery hold down
1	Deans plug on a charging lead

Needed Components

1	Radio Transmitter (TX) 3 channels w/mixing
1	Receiver (RX)
2	Micro servos are recommended (approximately .65 ounces)

Assemble Wings There are three parts to each wing panel. Separate the top and bottom beds from the wing cores. Lightly block sand the wing panels (cores) with #320 paper and round the leading edge (LE). **(See Figure 1)**

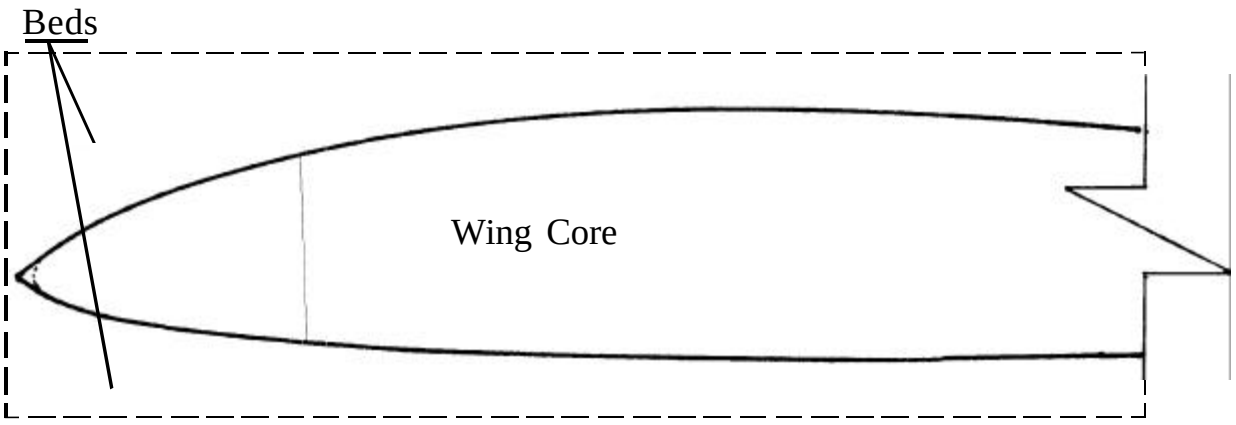

Figure 1

Tape the top beds together with a few pieces of fiber tape across the center. Put them aside and tape the bottom beds together. **(See Figure 2)**

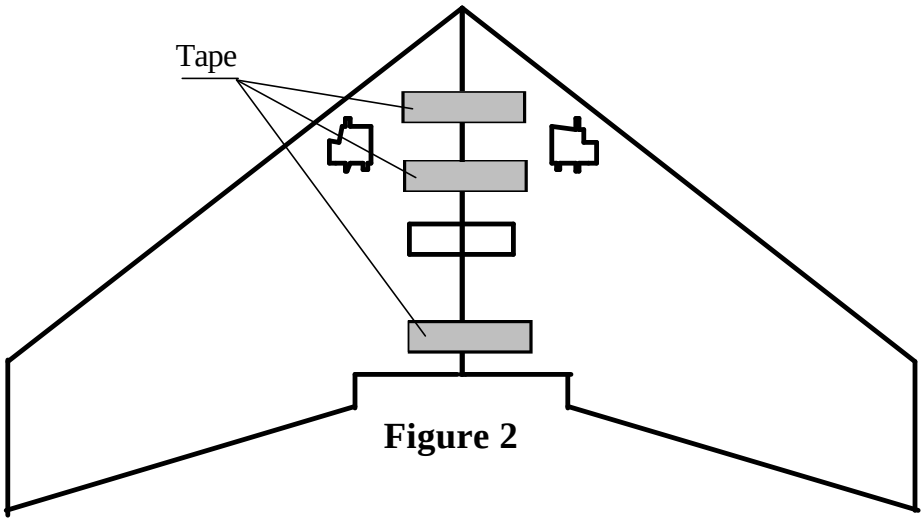

Figure 2

Do not remove the receiver bay cutouts at this time. Spray the root end of the wing cores with 3M type 77 Spray Adhesive. Hold the spray head 1 inch from the root. Spray a long bead along the root edge. Spread the bead with a small brush or scrap foam. Let the adhesive dry to the touch. Put the wing cores together and tape them in place until the glue dries.

(See Figure 3)

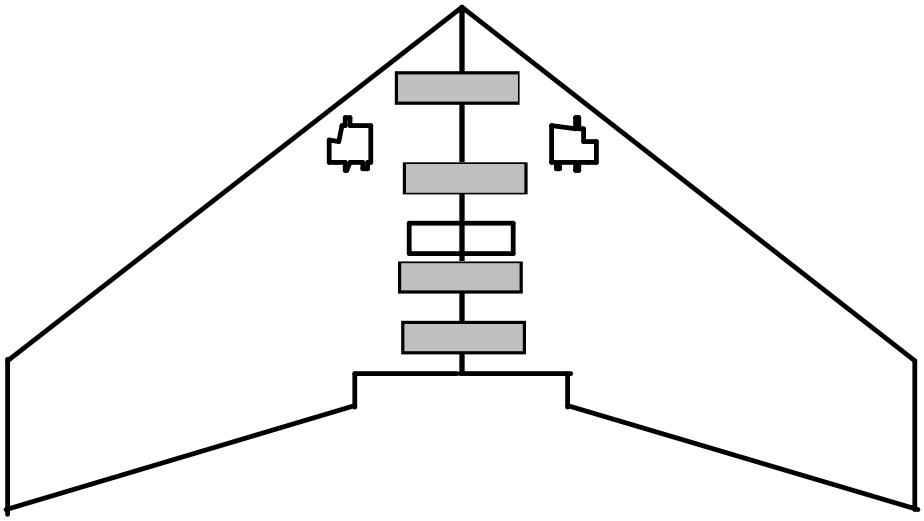

Figure 3

Check Then Install Servos Plug the servos and a battery into the receiver. Put the servos on the wing in the position shown in the above diagram. Turn the receiver (RX) and the transmitter (TX) on. Move the TX stick to the right. The servo on the right side should rotate the servo arm toward the nose. The left servo should move in the opposite direction. Pull back on the TX stick. Both servos should rotate the servo arm toward the nose. Use the "X" servo control arm. Cut three of the arms off of the X.

The servo bays are die cut in the wing panels. The wing thickness will accommodate micro servos. Servo control arms should be straight up facing outboard—toward wing tips. Some servos are bigger than others. It may be necessary to cut or router the servo holes to a tight squeaky fit. Locate the servo cut out in the wing panel. Push the cookie cut-out out of the wing. Slice a 1/2 inch wafer off the bottom of the cookie. Spray a puddle of #77 on a piece of scrap paper. Touch the edges of the parts to be glued in the puddle. Glue the wafer back in the bottom of the servo bay as a servo bay floor. Push the servo into the bay and cut the top of the cookie to fit as a servo bay lid. Make sure the lid is flush with the top of the wing. **(See Figure 4)**

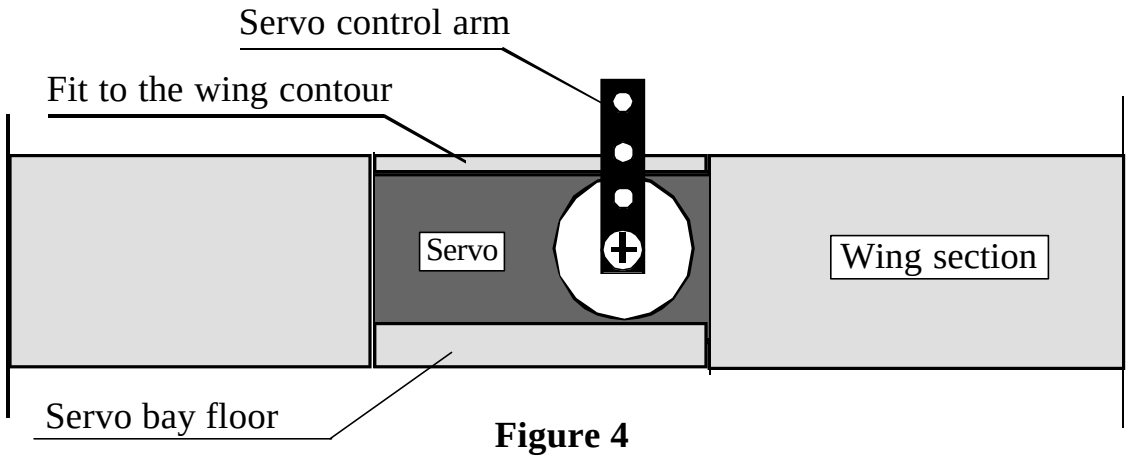

Figure 4

Install Receiver Push the receiver bay cookie out of the center of the wing panels. Cut the receiver bay larger if necessary. Cut 1/4" wafer off of the bottom of the cookie and make a floor for the receiver bay. Make sure that the receiver is flush with the top of the wing. The receiver bay does not need a top. Make a 1/2 inch deep cut between the servo bays and the receiver bay to accommodate the servo wires. Push the servo wires into the 1/2 inch cut. Rotate the servo control arms out of the way of the servo tops. Put the servo bay covers in place. Apply a piece of fiber tape over the covers. Roll up the antenna wire and temporarily tape it on the top of the receiver. Make sure that all of the radio parts are covered before spraying. Lay the wing in the beds top-side up. Apply a coat of 3M #77 spray adhesive to cover the top of the entire wing. Allow the adhesive spray to dry at least 30 minutes. Repeat this procedure on the other side.
(See Figure 5)

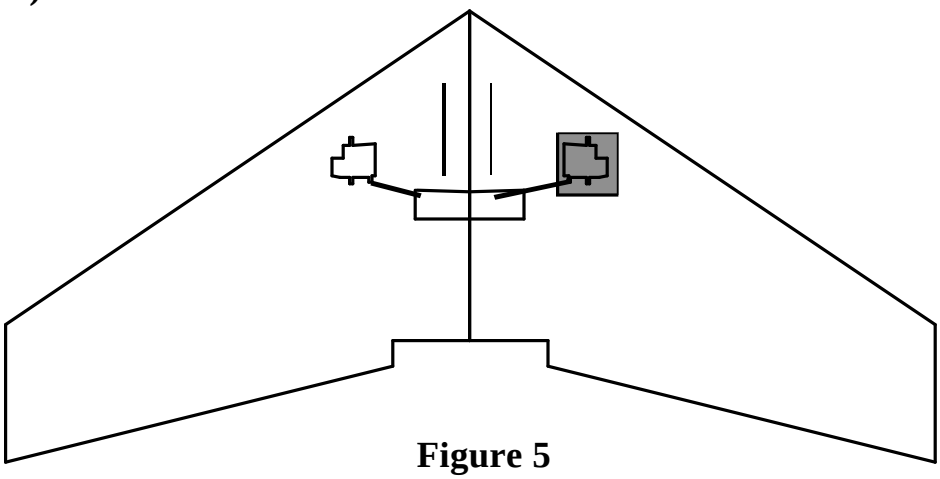

Figure 5

Taping Wings for Strength Lay the wing top-side up in the bottom beds. Wrap a strip of 2 inch fiber filament tape around the trailing edge (TE) between the wing tip and the prop cutout. Apply a strip of 2 inch fiber filament tape to the trailing edge to extend to the opposite leading edge. Apply two spanwise strips of tape at the motor tray cutout extending to the leading edge on both sides. Apply another two spanwise strips of 2 inch fiber tape in the center of the wing 4 inch from the motor tray cutout. Apply two strips of fiber tape diagonally from the nose to the outboard tip of the (TE). Lay the wing bottom-side up in the top beds and repeat the same taping procedure on the bottom side. Spray the fiber tape with # 77 adhesive and let it dry to the touch. **(See Figure 6)**

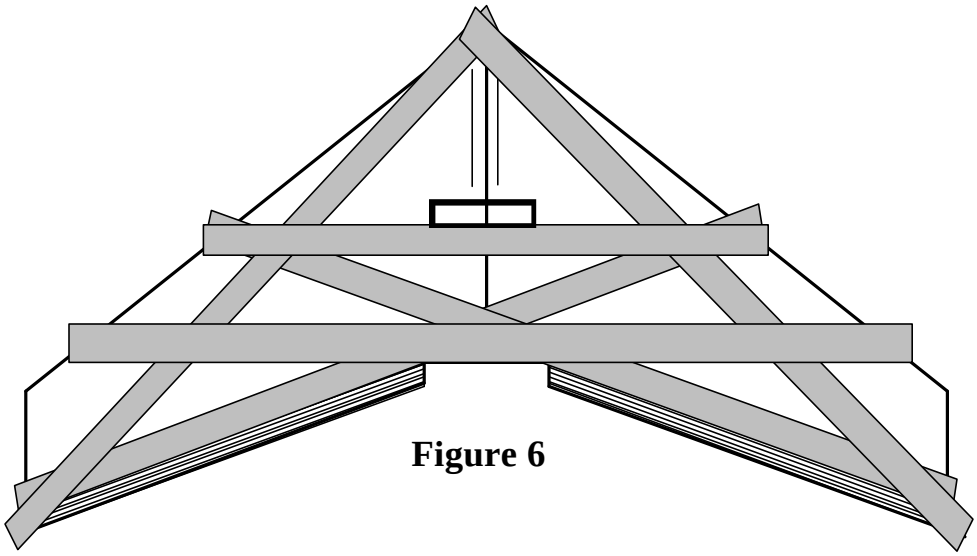

Figure 6

Start the color tape covering at the TE of the wing by wrapping a strip of tape around the TE being careful to follow the shape. Work from the TE forward. Lay strips of tape from tip to at least 4 inches past the center. **(See Figure 7)**

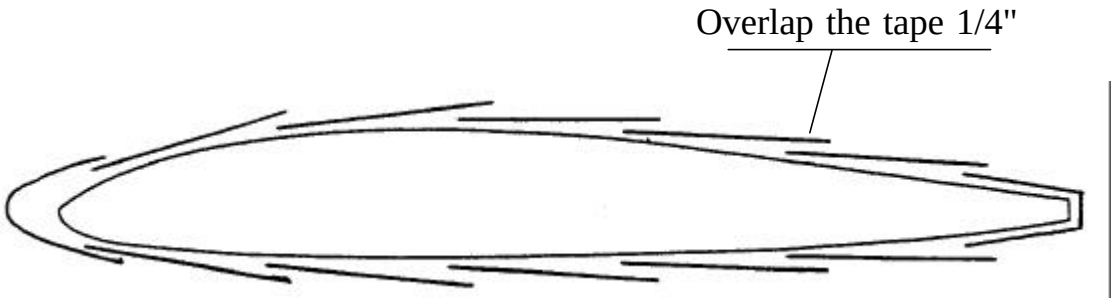

Figure 7

Cover With Colored Tape Lay the wing in the top beds bottom-side up. Start the color tape covering at the TE by wrapping a strip of color tape around the TE being careful to follow the shape. Working from the TE forward, lay strips of tape from tip to **at least 4 inches past center**. Overlap the tape only 1/4 inch all the way from the center to the tip. Cut the tape to match the angle of the leading LE. Place the wing in the top-side up in the bottom beds and repeat the taping procedure working from TE forward to the LE. Finish the leading edge with a single spanwise piece of tape wrapped around the LE. **(See Figure 8)**

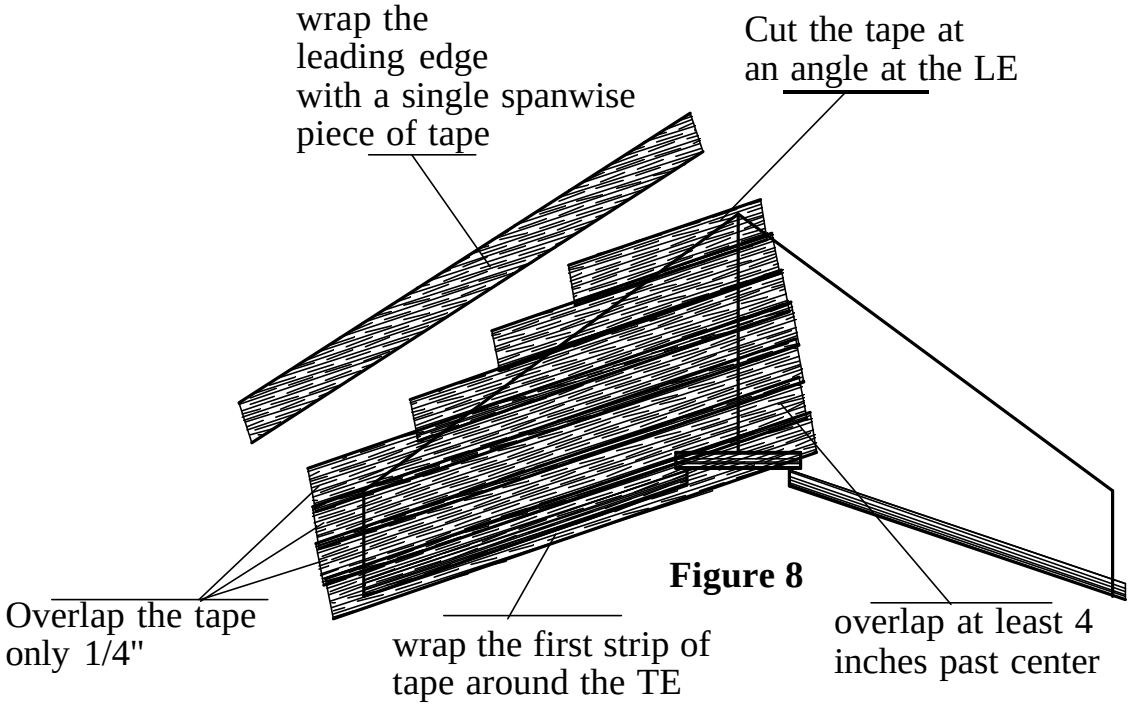

Figure 8

Prepare and Attach Elevons Hold the elevons together and sand them until they are identical. Trim the outboard end to match the angle of the wing tip. Trim the inboard end of the elevon to match the angle of the motor cut-out. **(See Figure 9)**

Round the top of the trailing edge of the elevon. Sand a 45° angle into the front of the elevon. **(See Figure 9A)**

Spray the elevons with any spray enamel. Primer works well. Apply a light coat of paint and immediately wipe it with a cloth before it soaks in and dries. Let the paint dry and repeat the procedure one more time. Let the paint dry.

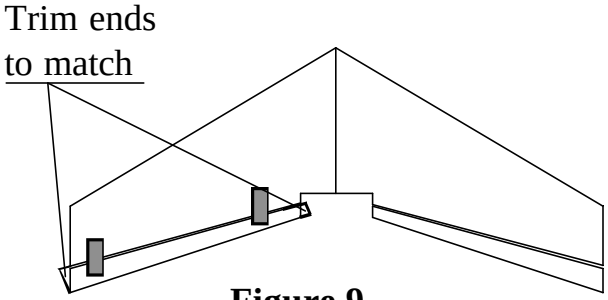

Figure 9

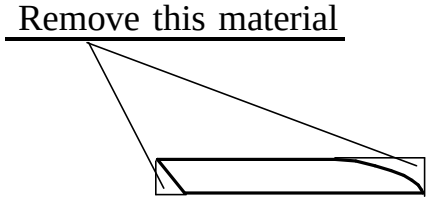

Figure 9A

Make sure that the paint is dry. Position the elevon on the trailing edge of the wing with small pieces of masking tape. Move the elevon to check for binding. Peel the paper backing from the 1'' X 3 mil mylar hinge tape. Align the hinge tape by holding the peeled tape over the seam. Secure the elevon by pressing the hinge tape in place at one end. Press the hinge tape down along the length of the elevon. Remove the masking tape. Make a tape hinge the full length on the top side of both elevons. Scrape a piece of plastic along the hinge tape to press the hinge tape to the elevon. A credit card works well.
(See Figure 10)

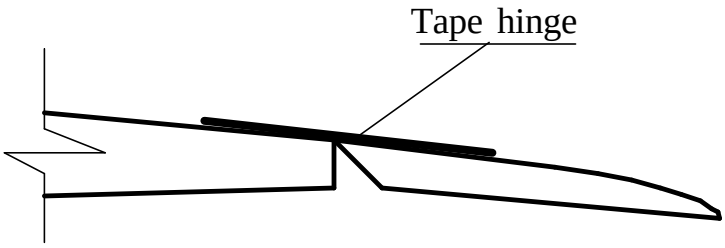

Figure 10

Attach Servos to Servos The control rods may not fit in the servo control arm. The end of the control rod can be filed to fit in the servo control arm or the holes in the servo control arm can be reamed by spinning an Xacto #11 blade in the hole. Attach control rods to the servo control arms with a Z-bend. Make a 10 degree bend in the control rods 1 inch behind servo to prevent binding.

Position the control horns on the elevon directly behind the servo control arm. Mark the position of the control horns. Drill two holes. Install the control horns on the elevons. Attach the control rods to the top hole of the servo control arms. Attach the clevises to the control horns. **(See Figure 11)**

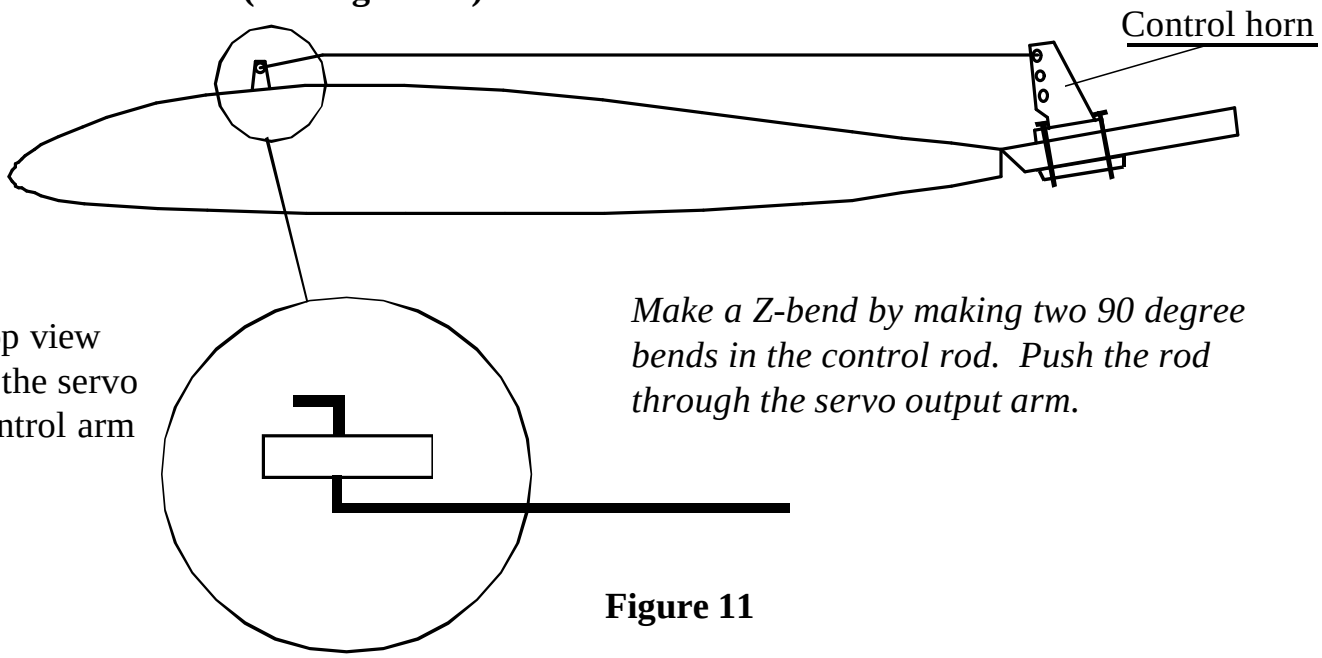

Figure 11

Attach Electronic Speed Control The Zagi-20 ESC, (electronic speed control) is provided in the kit. The red and black pair of wires with the red male Deans connector plugs into the battery. The red and blue pair of wires with the separate spade connectors plug into the motor. The Zagi-400 uses a pusher configuration which requires a reverse rotation motor. Reversing the rotation of the motor is achieved by reversing the polarity to the motor. Look at the flat surface on the back of the motor. Observe the red dot next to one of the motor terminals. Push the spade connector with the blue wire on with gentle pressure with a side to side motion. Attach the red wire with the spade connector to the other motor terminal. For a more positive connection, cut the spade connectors off and solder the wires to the motor terminals. The third set of wires is the three wire ribbon lead with the JR type servo connector. The JR connector will work with all radios except the old Airtronics. The red and black wires must be reversed in the plastic housing to change to the old Airtronics system. Plug the connector into the motor slot in the receiver. Plug the servo connector into the throttle slot of the receiver. No separate battery is needed to operate the servos. The motor and servos are powered by the battery provided in the kit. **(See Figure 12)**

Caution: The speed control turns on when the battery is plugged in. Make sure that the transmitter is turned on with the throttle setting all the down before the battery is plugged in.

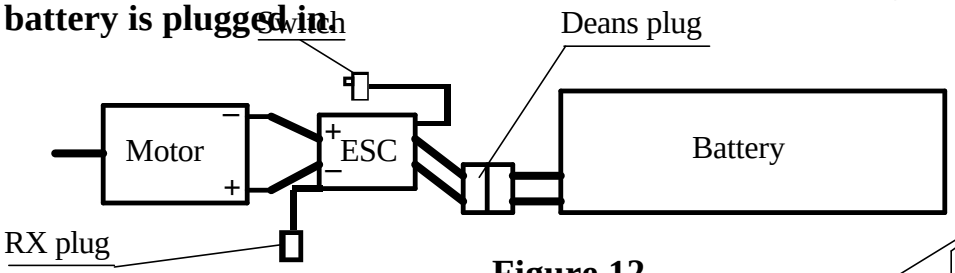

Figure 12

Prepare and Install Canopy Trim the motor tray with a scissors along the cut line. Notice that the cut line is the impression 1/2" from the side rails of the compartments. Position the motor tray over the center of the wing. Check the receiver position. Make a cut-out in the rear bay of the motor tray to provide access to the input slots of the receiver. Trim the canopy along the cut line. Notice that cut line is easier to cut when viewed from the inside. Cut the back off of the canopy.

Install Antenna Draw a line from the receiver to 1 1/2 inches from the LE. Continue the line spanwise 1 1/2 inches from the LE to the wing tip. Make a 1/2" deep cut along the line. Push the antenna into the slot with a flat blade screwdriver. Retape over the cut. The antenna will extend beyond the tip. Let it hang out. **(See Figure 13)**

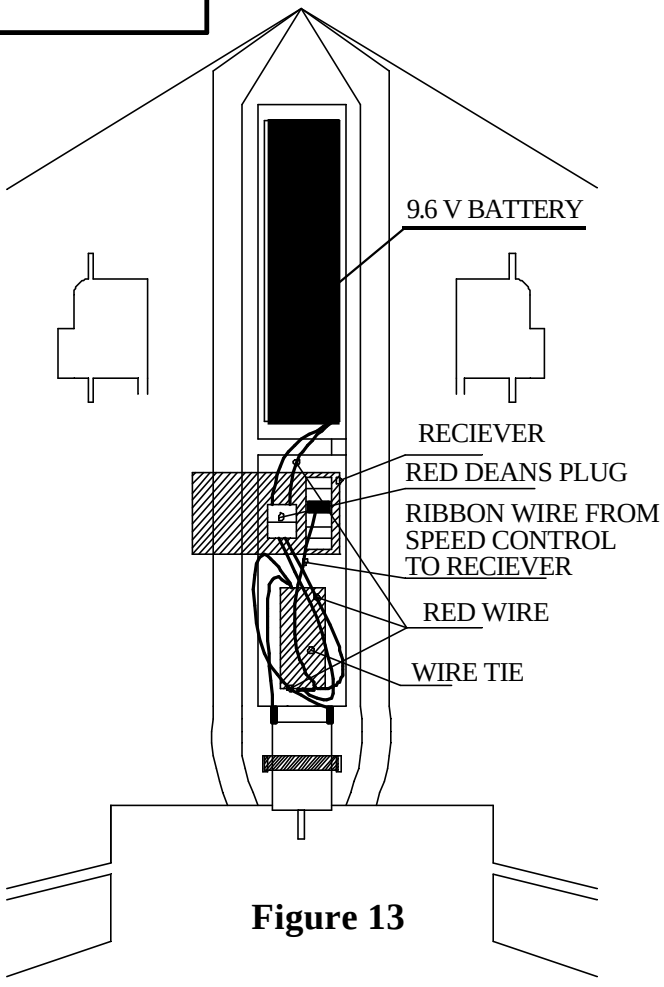

Figure 13

I**nstall Motor** Attach the motor to the tray with a wire tie. Locate the dimples on the rails on either side of the motor mount. Spin an Xacto blade in the dimples to make a hole. Elongate the holes to fit the wire tie. Push the wire tie through from the bottom of the tray. Set the motor in the motor mount. Make sure that one of the screws of the speed control match the depression in the motor tray. Wrap the wire tie over the motor and through the hole on the opposite side. Thread the wire tie and pull it tight. Hold the tail of the wire tie with a pliers and give it a good strong tug. Trim the tail off the wire tie.

Attach Velcro Peel the protective paper off of the hook side of two strips of Velcro. Stick the strips to the battery 1/2 inch from each end. Press the loop side to the hook side and peel the paper. Press the battery in place with the sticky side down.
(See Figure 14)

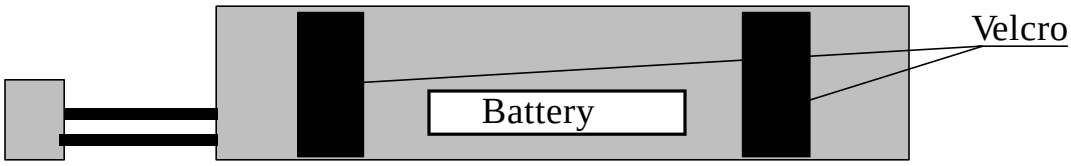

Figure 14

Cut one of the strips of Velcro into three equal pieces. Stick the hook side of one of the small strips of Velcro to the nose of the motor tray. Stick the hook side of one of the small strips of Velcro to either side of the back of the motor tray. Put the loop side of the Velcro loop side down on the hook side. Peel the paper off of the loop side. Place the canopy over the motor tray, nose first. Spread the back end of the canopy and lower it onto the motor tray. Align the motor tray with the nose. Make sure that the motor tray is centered over the center line at the trailing edge. Attach the motor tray with a strip of fiber tape on each side. **(See Figure 15)**

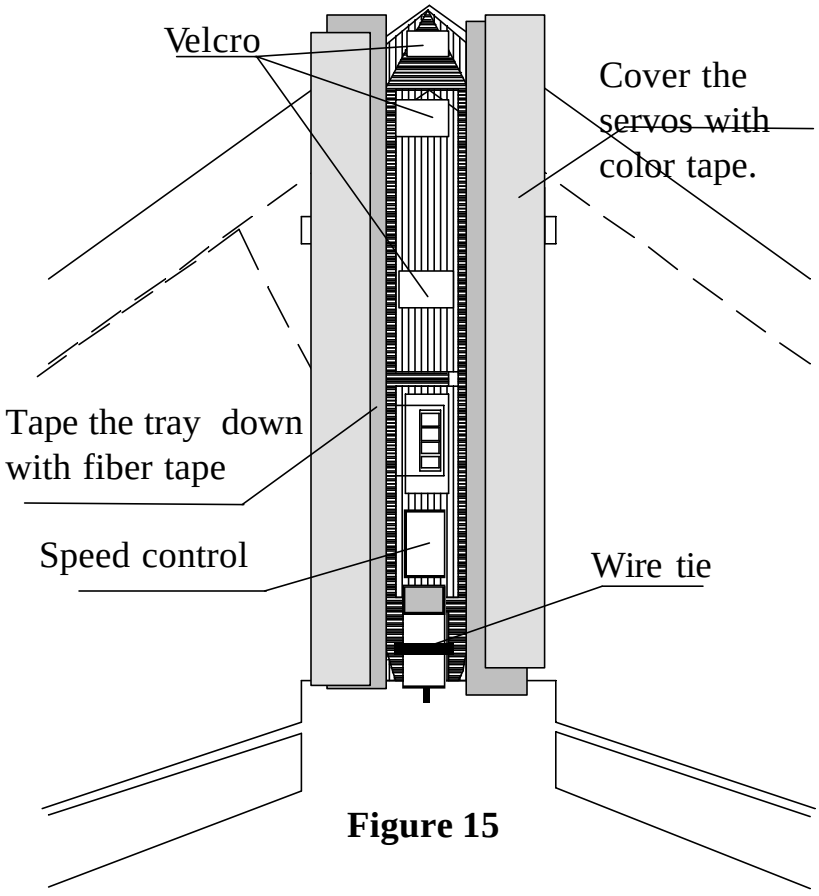

Figure 15

(See Figure 16) Punch-out and separate the two nested clear winglets. Punch-out the 1 1/4" x 1/4" slot in the winglet**.**

(See Figure 17) Put a piece of fiber filament fiber tape through the slot to the top of the wing and wrap it around to the bottom of the wing. Add two more pieces of tape to secure the winglet in place. Make sure that the elevon will not bind against the winglet as it moves.

The winglets are at the very back of the airframe so they will seriously impact the balance of the plane. The tape method of fastening is both light and strong. If a different winglet fastening system is preferred, keep the weight down to the weight of three short strips of tape.

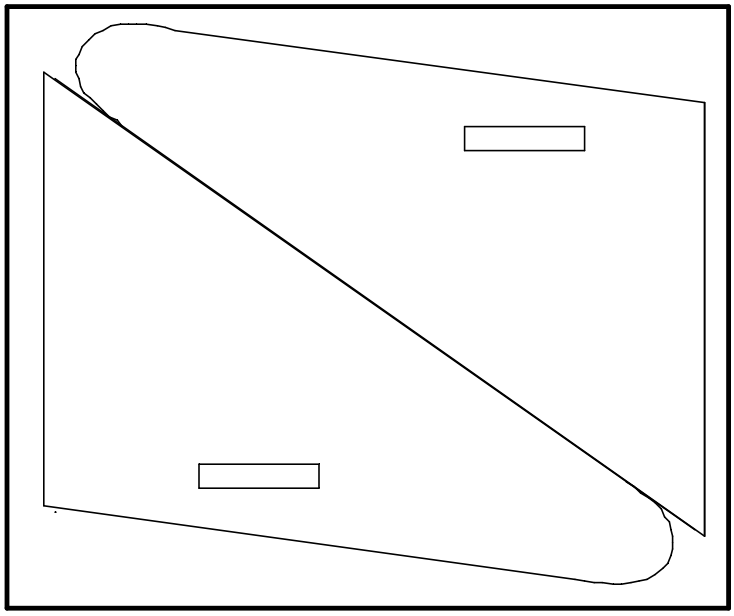

Figure 16

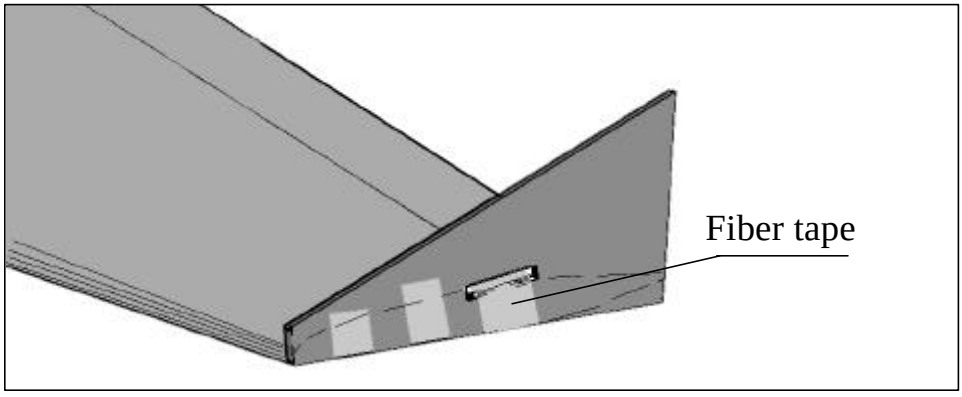

Figure 17

Balance Lay wing bottom-side-up. Using a square, mark the CG by making a line perpendicular to the center line 7 1/2" back from the nose on both panels. **(See Figure 18)** Tape a 1/4" dowel directly over the CG line. A round pencil or ball-point pen can be used. Place the wing right-side-up on a flat surface. Balance is achieved when the wing balances momentarily on the pencil. When the wing stays in either the nose down or nose up position balance is achieved. Add lead nose weight under the battery tray if necessary to achieve balance.

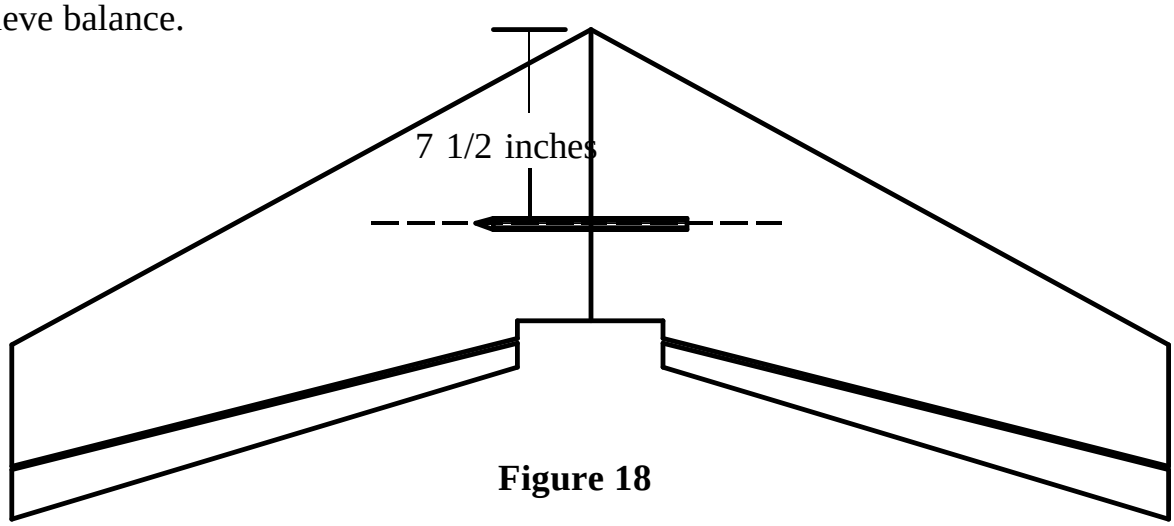

Figure 18

Set the elevon neutral setting by laying a straight edge under the wing at the trailing edge. The elevons should appear to have 2 or 3 degrees of reflex (up elevator). **(See Figure 19)**

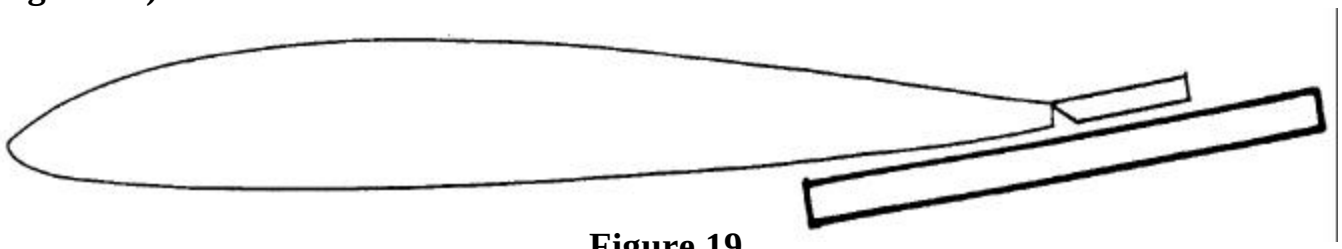

Figure 19

Setting Trim and Throw

Move the transmitter aileron stick from full right to full left (not up or down). The elevon throw should be 1/4" in each direction measured 1" from the tip (no differential). When moving the elevator stick full up to full down, the throw should be 1/4" in each direction. If the TX is equipped with dual rates, set the elevator and ailerons at 60% to start.

Counter Rotate Prop Set-up

The prop must be reversed to operate in the reverse direction. **The raised lettering on the propeller blades should be on the spinner side.** Remove the spinner and hub. Hold the prop by the blades spinner side up. Press it on a flat surface. Grip the spinner and gently twist and pull the hub from the prop. Reverse the prop and replace the hub so that the raised lettering is on the spinner side of the prop. Make sure the prop and hub are pressed firmly on the motor shaft.

First time motor power-up

The following steps are provided for a safe first time power-up of the motor. Do not press the prop onto the motor shaft. Test the motor hookup before the prop is installed. Make sure that the battery is charged. The batteries are not shipped with a charge.

SANYO RECOMMENDS CHARGING THE N 500A CELL AT A RATE UP TO 500 mAh FOR THE LONGEST BATTERY LIFE. 500 mAh WILL CHARGE THE 7 OR 8 CELL BATTERY IN ONE HOUR. AT THE RISK OF A SHORTER BATTERY LIFE, MOST MODELERS REGULARLY CHARGE THEM FOR 30 MINUTES AT 1 Amp. IF THIS CHARGE RATE IS UNSATISFACTORY, YOU NEED N 500AR CELLS. N-500AR CELLS WILL CHARGE IN 15 MINUTES AT A RATE OF 2 Amps .

1. Make sure that the motor is seated and securely attached to the motor mount.

2. Make sure that the reverse switch for the motor stick on the transmitter is in the normal position. Not reversed!

3. Push the motor control stick on the transmitter to the full down position.

4. Push the motor control stick trim lever (next to the motor stick) to the full down position.

5. Turn the transmitter power on. Check the output meter for battery condition.

6. Charge the motor battery and secure it in place with the Velcro tabs.

7. Plug the speed control signal lead into the motor slot of the receiver.

8. Position yourself with the nose of the airplane pointed at you. Plug the battery into the speed control.

9. Turn the speed control switch on.

10. Move the trim lever for the motor control stick slowly upward to the center posi tion. The motor should not move.

11. Move the motor control stick slowly upward. The motor should run faster the further up the stick is moved. The motor should turn counter clockwise when observed from the front.

12. Unplug the battery from the speed control. Press the prop onto the motor shaft. Rotate the prop to make sure it is clear of any obstructions.

Preflight check and glide test

Do a preflight check before every flight. Always turn the transmitter power on before the motor battery in the airplane is plugged in. Make sure that the motor control stick is in the full down position. Make sure that the controls are working properly. Check the trim levers on the transmitter. Pull the control stick back and observe that both elevons move upward. Push the control stick to the right and observe the right elevon moves up and the left elevon moves down. Hold the Razor securely by the nose. Move the throttle stick to the half throttle position momentarily. The first glide test should be done on flat land in a light breeze. The Razor should be held by the nose with your palm up over your head and your thumb wrapped around to the top. (See figure 21) Hold the Razor over your head with the nose pointed straight ahead. Run slowly into the wind. Give it a gentle push STRAIGHT AHEAD. **Do not point the nose upward.** Correct the flight path with the radio control stick. The test is successful when the Zagi-400 flies straight ahead with a slow sink rate to a sliding landing. If the Razor turns in either direction after the launch, compensate by adding 2 or 3 clicks of trim in the opposite direction with the trim lever below or next to the control stick. If the Razor pitches up and immediately dives, add 2 or 3 clicks of down trim. Repeat the glide test until the Zagi-400 flies straight ahead with a slow sink rate to a sliding landing. Increase the launch speed each time to provide longer control flights.

First flight

DO NOT LAUNCH THE RAZOR WITH THE MOTOR RUNNING. Hold the Razor by the nose with your palm up over your head and your thumb wrapped around to the top. Take a step or two forward and give the Razor a good strong throw into the wind. A follow through with a little finger tip will increase the launch speed. Slide the throttle stick to the full forward position when the Razor is a comfortable distance from the ground. Get some altitude and experiment with some throttle settings. Full motor is fun but will use up the battery quickly. **(See Figure 21)**

Good luck,

JT

Battery Life and Power Management

Battery life is a determined by two main factors; charging and discharging. Both of these functions produce heat. Warm is okay, hot isn't. A hot battery has either been charged or discharged too fast. First, charging. Make sure that the charger is designed to charge the number of cells being charged. The best type of charger is the peak detector type. These chargers will charge the battery to peak at a pre-selected rate then drops to a trickle. Chargers with timers will often over charge batteries causing excessive heat. Manufacturers recommend charging batteries at the rated capacity *i.e.*, a 500 mAh battery should be charged for one hour at 500 mAh. The exception to this is the batteries with the letter "R" at the end of the designation (500AR, or 2000SCR). The "R" means rapid charge and discharge. "R" cells are either very expensive or not available. Hobbyists are notorious battery abusers. Batteries that are not designed for rapid charge are routinely over charged by charging and discharging them too fast. NiCad cells have a finite number of cycles. Abuse will decrease the number of cycles. Electric flight hobbyists are willing to accept the shortened life of the batteries for performance. There are ways to cut these losses. Don't charge at a rate more than twice the designated capacity of the battery. Don't charge a hot battery. Get enough batteries to fly one, cool one, and charge one. A way to speed up the cycle is to make a 12 volt field battery cooler. Tape a 12 VDC muffin fan to a 6 inch length of 2 inch PVC pipe. **(See Figure 20)** The Muffin fan is available at Radio Shack or find an old computer power supply fan (but make sure it's designed for 12 VDC and not 110 VAC).

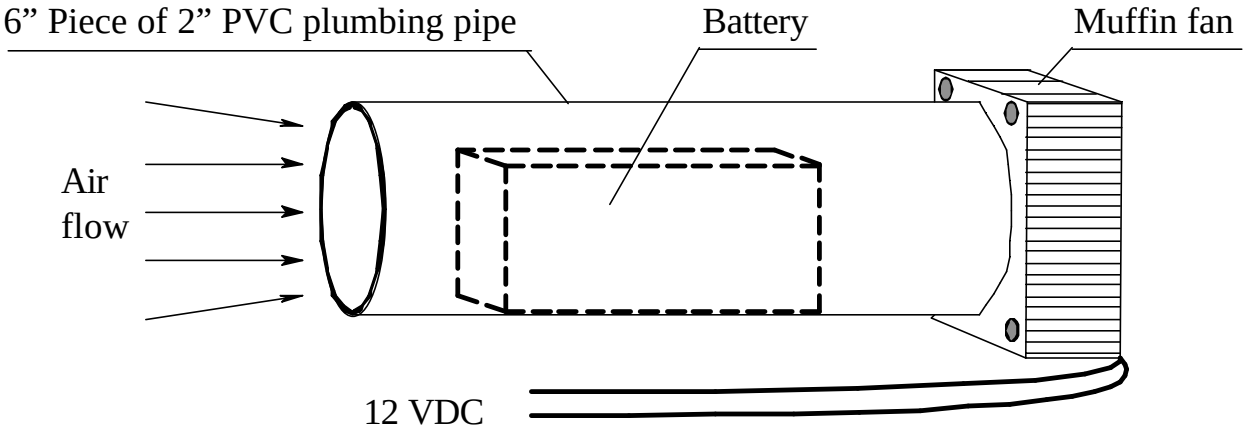

Figure 20

Discharging the battery at the rate of 10 to 15 amps is the other way electric flight hobbyists abuse batteries. These high discharge rates produce heat. Again there are ways to cut your losses. Airflow over the battery during flight will help. Vent holes in the cowling is a good idea. But more important is the throttle settings during the flight. Full bore for the entire flight is definitely too hot. Try some throttle off time and some half throttle time. This will extend the flight time and battery life.

Modifications The challenge of making any modifications on flying wings is the trade-off between the advantage and the penalty. Structural modifications made to the airframe should be made with caution. Since most mods involve adding weight, and more than likely behind the CG, mods should be avoided. If care is taken in the building process, the weight will be right on the manufacturers listed weight. Mods made to save weight are the best approach to building. Having said that, Here's a few mods that will work in a positive way.

One way to save weight is to use as little of the adhesives and tapes as possible. Instead of thinking a little more tape or glue will make the airplane better, think how little of each will it take to make it as strong as it needs to be. Epoxy makes a heavy wing joint and spar adhesive. The 3M Super #77 Spray Adhesive will make an adequate bond. Remember, you're only bonding to one pound foam. The foam will usually fail before the bond will. Saving weight on the elevons will reduce the need for nose weight. Some balsa elevons are heavier than others. Elevon weight can be reduced by shaping. If the elevons seem heavy replace the elevons supplied with the kit with extra light weight contest grade balsa. Winglets made of meat tray styrofoam are lighter than the stock material although not nearly as strong.

Covering materials like Ora Cover or Ultra Kote are heavier than tape. The lighter materials like Solar Film are light but not as strong as tape. There are some problems using iron-on covering materials. Heat shrink materials can distort the geometry of the wing. Designs can be made with the color tape by alternating colors in a variety of patterns without adding weight.

Changing the propeller to a different pitch or diameter will require a prop adapter. Once again, the dorky little white Gunther prop supplied with the kit tested better on the Zagi-400 motor than all other props available, but you have to remember to reverse the hub. The Zagi-400, 400X and Razor are supplied with a balanced power system. Changing the prop will change the load on the ESC and the battery. The Zagi-20 ESC is rated at 20 amps continuous. The Razor with a 500 mAh battery and the stock prop draw 12.5 amps at full throttle. So if the prop diameter or pitch is increased, the load could exceed the range of the 20 amp ESC. Trial and error can get expensive. The way to prop electrics is with the use of a watt meter. Astro Flight makes a "Super Whattmeter for outdoor R/C models" for $55.00 from Trick R/C. This device will keep the smoke from escaping from the speed control. Another useful tool is a tachometer. Cermark makes a good tach for cheap. A simple thrust meter can be made with a small postal scale calibrated in ounces. A test stand setup with a wattmeter, a scale and a tach will take the guesswork out of balancing electric components.

Throwing the Razor

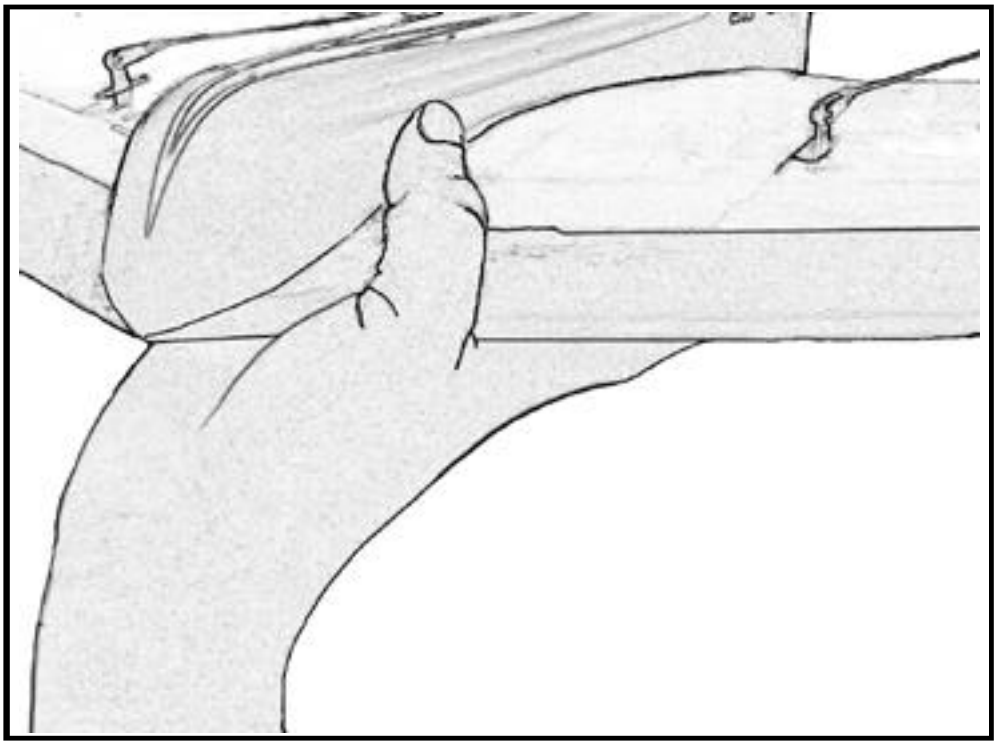

Figure 21

Hold the Razor by the nose with your palm up over your head and your thumb wrapped around to the top. The secret to this launch is the energy you exert with your fingers in the follow through.