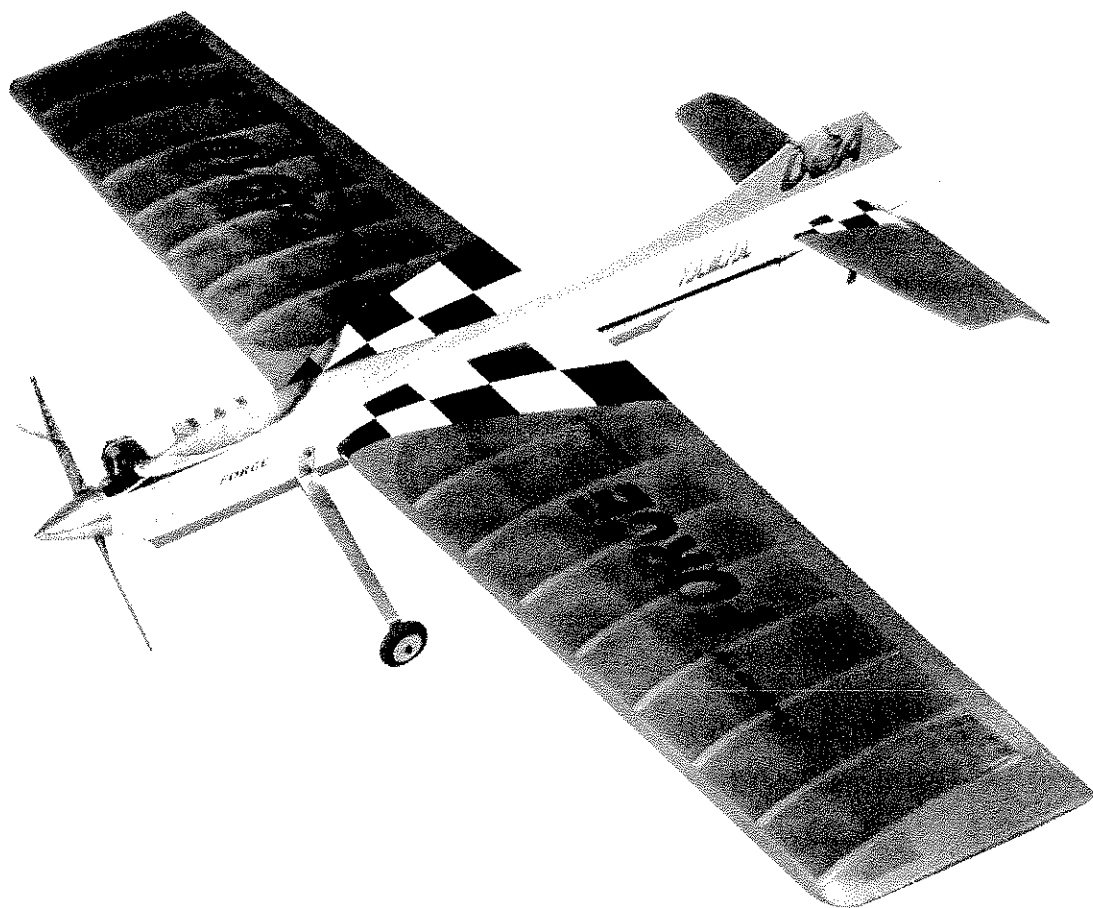


# ***Primary Force***

**Designed By: Mike Pratt**



## **Building & Flying Instructions**

### **Mikey's Models**

199 Glenrose Dr.

Pueblo West, Co 81007

719-647-0541

[mikeypratt@mindspring.com](mailto:mikeypratt@mindspring.com)

<http://home.mindspring.com/~mikeypratt/index.html>

From the beginning, the Primary Force was designed to be a competitive stunter, and its origins lie in the Force series of models that I designed (Force, Magnum Force, and G-Force). The reason for the name "Primary" is that it is really easy to build, trim, and fly. It makes an excellent model for the beginning stunt flyer and expert alike. It will teach you the basic trimming skills needed to be a competitive stunt flyer without the complexity of a flapped model. Most experts that have flown the Primary Force like it for its simplicity and praise it for its honest and superb flying characteristics. The Primary Force is equipped with all the modern day trimming devices and can be flown with many of the existing .25 to .35 stunt engines. **Note: Carefully read and review the plans before beginning construction.**

## Fuselage:

1. Glue the front and rear halves of each fuselage side together using medium CA glue and pin the halves down flat on a building board covered with wax paper. When the glue has cured, laminate the two fuselage sides together with slow drying epoxy. Place the fuselage on a flat building board, weight down and allow the glue to cure overnight. **See Alternate Method #1 in back of this book.**
2. The spacing of the engine mounts is set for the OS .25 and Fox .35. If you are using a different engine, then you must adjust the spacing of the mounts accordingly. Glue the maple engine mounts in place with slow drying epoxy and allow the glue to cure.
3. Glue a piece of 1/2" square balsa vertically to the front of the fuselage and mounts as shown on the plan.
4. Again, using slow drying epoxy, glue the plywood fuselage doublers onto the sides of the fuselage. **See Alternate Method #2 in back of this book.** Place the fuselage on a flat surface and weight it down until the glue has cured. **NOTE:** If you intend to power the Primary Force with a Fox .35, a 1/2" diameter hole must be drilled in the outside plywood fuselage doubler to clear the bottom backplate screw on the engine. Do not remove the plywood from between the engine mounts on the outside plywood doubler.
- MISSING 5. Laminate the balsa canopy halves together with medium CA glue. Glue the canopy onto the fuselage in the location shown on the plan.
6. Glue the fin and rudder together using medium CA glue making sure that you offset the rudder to the left (outside of the flying circle) 1/8".
7. Glue the fin and rudder assembly onto the fuselage and carefully align the fin and rudder with the fuselage making sure that it is perfectly straight.
8. Carefully study the cross-sections that have been provided on the plans. Using a razor plane, roughly carve the fuselage to shape closely matching the cross-sections. Taper the last three inches of each side of the fuselage to blend the fuselage sides into the rudder. Finish shaping the fuselage with a sanding block and 100 grit sandpaper. Apply a lightweight filler to the fin and fuselage joint and around the outside edges of the plywood doublers. When the filler is completely dry, use a sanding block with 220-grit sandpaper and blend the edges of the plywood doublers smoothly into the fuselage. Referring to the cross-section on the plan, carefully contour the filler and the fuselage sides to giving a smooth transition between the fuselage and vertical fin.

9. Drill the mounting holes for your engine and install 4-40 blind nuts in the outside plywood doubler. Secure the blind nuts in place with CA glue.
10. Finish sanding the fuselage with progressively finer sandpaper.

## Stabilizer & Elevators

11. Cut two lengths of 1/4" birch dowel that are 1/4" long and glue them into the left elevator (as shown on the plan). Using a sanding block and 100-grit sandpaper, taper the elevators from 3/16" at the leading edge to 3/32" at the trailing edge.
12. The elevator joiner is made from 3/32" music wire. Make sure that you install a 1/8" o.d. X 1/2" brass bushing before bending the ends of the elevator joiner wire.
13. Mark the location of the joiner wire on each elevator and drill 3/32" holes into the face of each elevator in the previously marked locations. Epoxy glue the joiner wire into each of the elevators and allow the glue to cure.
14. Round the leading edges of each of the elevators.
15. Pin and tape the elevators in place on the stabilizer. Round the leading edge of the stabilizer and tips of both the stab & elevators.

**NOTE:** This would be a good time to decide if you are going to cover the Primary Force with an iron on covering or use the traditional silkspan and dope method (see Finishing at the back of these instructions). If you use one of the iron-on coverings to cover the stab & elevators, then use (4) plastic pinned hinges to attach the elevators to the stabilizer in the next step.

16. Slide the elevators into the slot in the rear of the fuselage and slide the elevators to the rear of the slot. Insert the stabilizer into the same slot, with the leading edge of the stabilizer against the front of the slot. Center the stabilizer in the slot and pin in place. Attach the elevators to the stab with nylon cloth hinges (or plastic pinned hinges). Do not glue the stabilizer assembly in place at this time (see step # 42). Add a 1/4" balsa filler piece in the slot behind the elevator joiner.

## Wing Assembly

17. Cut out and tape in place the outboard section of the wing plan and place the wing plan on a flat building board and cover with wax paper.

**NOTE:** Make sure the building board is straight and true by placing a long straight edge on the board and looking for gaps between the straight edge and the board. If there are gaps place paper shims under the building board until it is straight.

18. Locate and mark each of the main beam spars. The longer of the two is the left wing spar and the shorter is the right (as if you were seated in the cockpit). Butt glue the two main beam spars together at the center section and pin down to the building board.
19. Laminate one of the two 1/32" birch plywood spar doublers onto the rear of the main beam spar with epoxy glue. Allow the glue to cure.
20. Mark the location of the 6-32 threaded rod for the bellcrank pivot and cut a slot halfway through the beam spar. Take your time and do this procedure properly.

21. Attach the leadout cables to the bellcrank by slipping an annealed (heated cherry red and allowed to cool) 2" piece of 1/16" o.d. brass tubing over each of the leadout cables. Bend a "U" shape in the brass tubing by wrapping the tubing 180° around an X-acto knife handle. Drill out the holes in the outer arms of the bellcrank with a 3/32" drill bit. Install the tubing and the leadout cables in the bellcrank and wrap the ends of the leadout cables with copper wire as recommended in the AMA rulebook. Refer to the plans and cut off the excess pivot arm on the bellcrank.
22. Make a bellcrank pivot from a piece of 6-32 threaded rod that is 2-1/2" long. Assemble the bellcrank and bearing onto the 6-32 threaded rod. Align the bellcrank in the center of the threaded rod and secure the bellcrank in place with two 6-32 hex nuts. Place a very small drop of CA glue on the hex nuts to secure them firmly in place.
23. Referring to the cross-section on the plan, install the bellcrank and leadout cables into the main beam spar and tack glue the bellcrank in place with CA glue. Make sure that the threaded rod is located in the center of the main beam spar when viewed from the top or bottom.
24. Epoxy glue the other 1/32" plywood spar doubler onto the front of the main beam spar. Allow the glue to cure.
25. Glue the 1/8" plywood spar triplers to the top and bottom of the main beam spar with medium CA glue. The 6-32 threaded rod should protrude through the plywood triplers. Install a 6-32 hex nut onto each end of the threaded rod. Cut off any excess threaded rod flush with the hex nut. Place a small drop of thin CA glue onto the hex nut and the end of the threaded rod to lock them in place. See the cross-section on the plans.
26. Make up a pushrod from a piece of 3/32" music wire that is 24" long. Make a 90° bend in one end of the music wire and solder a flat washer as close to the bend as possible while making the flat washer perpendicular to the bend in the pushrod (Use a piece of silicone fuel tubing to hold the washer in place when soldering). Solder another flat washer to the pushrod on the opposite side of the bellcrank. Use a small piece of sandpaper to insulate the bellcrank while soldering the flat washer to the pushrod.

**NOTE:** Keep in mind that the pushrod exits the bottom of the wing.

27. Slide the wing ribs for each wing panel onto the main beam spar. Place the ribs and the spar over the plan and pin each of the wing ribs in their proper location. Each wing rib has an alignment tab on the front and back (**do not remove tabs until instructed to do so**). These tabs must be square and flush with the building hold the washer in place when soldering. Install the pushrod into the bellcrank and secure in board. Pin each tab to the building board with two pins. When satisfied with the alignment of each wing rib pin each wing rib to the main spar. Do not glue the ribs to the spar at this time.
28. Make an upper and lower trailing edge sheet as shown on the plan by splicing two sheets of 1/16" balsa together with a large scarf joint as shown on the plan. Carefully position and pin in place the **BOTTOM** trailing edge sheeting. Place a straight edge on top and on the ends of the ribs and make sure that all ribs are in contact with the straight edge. It is also helpful to sight down the trailing edge from both ends to make sure everything is in alignment. When satisfied with the alignment, glue the end of the ribs to the trailing sheeting with Sigmant or Titebond glue. Do not use CA glue. When the glue has cured repeat the above step to install the top trailing edge sheeting.
29. Pin and glue in place the 1/2" square balsa leading edges. Take extra care and make a good fitting joint between the leading edges at the center section.
30. Recheck the alignment of the wing ribs and spars. Glue each of the wing ribs to the main beam spar with medium CA glue.

31. Add scraps of 3/32" balsa to the top of the main beam spar between the W-1 and W-2 ribs. **NOTE:** Remove the straight pins from W-1 and W-2 wing ribs only. Do not unpin the remaining wing ribs from the building board.
32. Sheet the center section of wing as shown on plan with 1/16" balsa. Do not omit the radiuses on the center section sheeting at the leading and trailing edges. These add a lot of strength and stiffness to the wing.
33. Glue 1/16" x 1/4" balsa cap strips to the top of each wing rib. Use a light sheet of "A" grain balsa to cut the cap strips from. Cut and trim to length each cap strip for each wing rib.

**NOTE:** The best method for installing the cap strips is to apply medium CA to the top of the rib and lightly spray the back of the cap strip with CA kicker. Starting at the leading edge, place the cap strip onto the rib and against the leading edge. Gently press the cap strip onto the rib while working your way to the trailing edge.

34. Remove the scribed on the end of the left main wing spar with a razor saw. Assemble the adjustable leadout guide as shown on the plan and install into the W-10 wing rib (on the left wing panel).
35. Laminate the wing tip parts together as shown on the plan. Glue the wing tips in place with medium CA glue. Unpin and remove the wing from the building board. Flip the wing over and block up the trailing edges with balsa blocks. Make up six 15/16" square balsa blocks that are pinned to the building board and evenly spaced along the rear of the trailing edge. Place 9/16" blocks under the main beam spars inside W-10 wing ribs and pin in place. Cutoff the alignment tabs on the bottom of each wing rib and remove any rough edges with sandpaper.
36. Make sure the control system is smooth and free of any binding and/or sticking. Place a 90° triangle along the inside edge of the trailing edge sheeting and align the outer holes (where the leadouts are attached) of the bellcrank with the triangle. These holes must be perpendicular to the trailing edge when the control system is in the neutral position. Mark and wrap the ends of the leadout cables making sure they are equal lengths.
37. Sheet the bottom of the wing center section and add the rib cap strips. Remove the wing from the building board and sand the tops of the wing ribs and center section sheeting with a long sanding block. Use progressively finer sandpaper until a smooth and even finish is achieved.
38. Carve and sand the wing tips to the cross-section shown on plan. The trailing edge of each wing tip is tapered to match the trailing edge sheeting.

**NOTE:** If you are going to use a Silkspar and/or Polyspar covering, all the major parts must be doped and covered before final assembly (see Finishing at the end of this booklet).

39. Assemble the tip weight box with medium CA glue and add a 4-40 blind nut to the bottom of the box. Position the tip weight box on the inside of the W-10 rib and glue the box to the main beam spar. Outline the top of the box with 1/16" x 3/8" balsa as shown on the plan.

## Final Assembly

40. Slide the wing into the fuselage and carefully align the wing to the fuselage (remember that the outboard wing panel is 3/4" shorter than the inboard wing panel). Pin and/or tape the fuselage in place. **DO NOT GLUE THE WING IN PLACE AT THIS TIME!**

41. Viewing the model from the front, make sure the fuselage is perpendicular to the centerline of the wing and the stab and elevator assembly is parallel to the wing centerline. Pin and/or tape the stabilizer and elevator assembly in place. Double and triple check the measurements and alignments before tack gluing the wing and stabilizer assembly in place. After tack gluing, it is always a good idea to recheck the alignments. Proper alignment is very important in order to have a good flying model. Take your time and do this step properly.
42. Glue the wing and stabilizer assembly to the fuselage using slow drying epoxy. Again, check the alignment of the model and allow the glue to cure.
43. Add a 3/8" radius fillet to the fuselage and wing joint using micro balloons and 5 minute epoxy or Sig Epoxolite. **Do not omit the fillet.** The fillet helps keep stress cracks from forming in the fuselage and wing joint and greatly adds to the longevity of the model.

**NOTE:** Finish covering and/or painting your model.

44. Attach a large nylon control horn to the elevator by marking and drilling through the 1/4" dowel hardpoints in the elevator. Use #2 sheet metal screws to hold the horn firmly in place.
45. Make a pushrod guide from 1/32" music wire by wrapping the 1/32" wire around a piece of 3/32" music wire leaving 1" long legs that are glued into the side of the fuselage. Place the pushrod guide midway between the wing and stabilizer.
46. Place the bellcrank and elevators in the neutral position. Place a mark on the pushrod that is in the center of the bottom hole of the nylon control horn. Make a 90° bend in the pushrod that is parallel to the stabilizer. Trim off the excess wire about a 1/2" after the bend. Drill out the bottom hole in the nylon control horn with a 3/32" drill bit. Solder a flat washer as close to the bend as possible while keeping the washer perpendicular to the pushrod. Insulate the nylon control horn with a small piece of sandpaper and solder a flat washer on the outside of the nylon control horn.  
**Alternate Method:** Use a Du-Bro 4-40 threaded coupler (part # 336) that is soldered to the end of the pushrod. In addition, use a Du-Bro 256 swivel ball link (part #2139) that is threaded on the coupler and attached to the nylon control horn with a 256 bolt and nut (use a lock nut). This method is reliable, strong, and makes it easy to make small adjustments to the controls.
47. The landing gear was made from .090 2024 T-6 aluminum that is 1/2" wide and 7-5/8" in length. The aluminum is easily bent with a simple bender made by placing two 3/4" sockets in a vise spaced 3/32" apart. Practice bending coat hanger wire until you get the hang of it. Both landing gear blanks are identical in shape and size. Drill the holes in the locations shown on the plan and attach the wheels as shown. Bolt the gear to the fuselage using 4-40 bolts and lock nuts. For those of you that do not want to try and bend your own gear, purchase a set of aluminum gear for the Ultimate Fun Fly from Sig (part # RP-BA-271). They need to be bent slightly to get the proper shape but they will work just fine.
48. Mount your engine with 4-40 socket head bolts and lock washers. No engine offset was required on the prototype. The fact of the matter was engine offset was attempted on the prototype by placing washers under the front mounting lugs on the engine, and they were removed during trimming process.
49. Mount your fuel tank using 4-40 J-bolts and rubberbands. Place a piece of foam rubber between the tank and the fuselage. This set up transfers less vibration to the fuel tank and minimizes fuel foaming and erratic engine runs. In addition, mount the tank with its centerline 1/8" to 1/4" above the centerline of the engine.

## Finishing

Please pay special attention to the notes placed in the instructions above. Some of them alert the builder to the fact that some of the parts should be covered before assembly. It has been my experience with traditional silkspan and dope that the wing, fuselage, stabilizer, and elevators should be covered before assembling the model. It is much easier to sand and repair defects in the major parts when they are not assembled.

## Silkspan & Dope Finish

Apply three coats of clear butyrate dope that is thinned 50/50 to the fuselage, wing, stabilizer, and elevators. Lightly sand between each coat with 220-grit sandpaper to remove any fuzz, raised wood grain, and level out the high spots. Cover all parts with medium weight silkspan. Use a spray bottle to wet the silkspan that you intend to use. You do not want the silkspan dripping with water. Wet the silkspan just enough so that it is thoroughly damp. Apply the silkspan to the wing panel and remove as many of the wrinkles as possible. Apply thinned dope around the outside edges of the wing and continuing to pull out more wrinkles. Trim off the excess silkspan and apply one more coat to the outside edges of the wing. Next, cover the opposite side the wing panel you just covered. This will help keep the wing from warping while the silkspan dries. Repeat the above process on the remaining wing panel and other parts. Apply four coats of thinned butyrate dope to the wing by applying the dope to one or two rib bays at a time. Alternate from the top to bottom of the wing as you work your way out towards the wing tip. Again, this will help keep the wing from warping while the dope dries. Apply four coats of dope to the other parts and lightly sand between each coat with 320-grit sandpaper. The model must now be assemble and have the fillets applied to the wing and fuselage joints. Give the fillets four coats of nitrate dope and allow the dope to dry. Apply three coats of sanding sealer to the entire model and allow the dope to dry for at least three days. This allows the dope to shrink and penetrate deeper into the wood grain. Wet sand with 320-grit sandpaper being careful not to sand through the silkspan. Spray on two coats of clear butyrate dope to seal off the sanding sealer. Lightly sand the model with 400-grit sandpaper. Apply two coats of base color and allow the base color to dry for two days. Use 3M drafting tape to layout the trim scheme and rub the edge of the tape your thumb or fingernail. Shoot clear dope on the edge of the tape to seal it and prevent tape leaks. After the trim has been applied, add the panel lines and detailing that is desired. Apply four coats of butyrate to the entire model and allow the dope to dry for a few weeks. If desired, wet sand the model with 1000-grit sandpaper to achieve a dull satin look. Rub out with 3M rubbing compound and apply a good wax.

## Iron-On Film & Quickie Finish

Cover the stabilizer and elevators with your favorite plastic covering. Remove the covering where the fuselage is glued to the stabilizer. Install the elevator and stabilizer into the fuselage and install the hinges (see step #16). Fill the remaining gap behind the elevators with a small piece of 1/4" balsa. Place 3M drafting tape along the edge of the fuselage and stabilizer joint to protect the film covered stabilizer. Apply three coats of nitrate dope to the fuselage lightly sanding between each coat with 220-grit sandpaper. Cover the fuselage with lightweight silkspan and nitrate dope. Glue the wing into the fuselage and add the epoxy fillets. Apply two more coats of nitrate clear over the fuselage and fillets. Lightly sand between each coat with 320-grit sandpaper. Cover the stabilizer, elevators, and wings with newspaper. Spray on two coats of Top Flite Lustercoat primer onto the fuselage and allow the primer to dry overnight. Lightly sand the primer with 320-grit sandpaper and remove sanding dust with a tack cloth. Spray on 3 to 4 light coats of Top Flite Lustercoat color. This stuff is not as light as dope so keep the coats as thin as you can. When your base color has dried add whatever trim colors and detail to the fuselage you desire. Spray on two coats of Top Flite Lustercoat clear on the fuselage and allow the paint to dry. This stuff is real shiny and does not need to be rubbed out. Cover the wings with the plastic covering and you are ready to go.

## Bench Trimming

**Tip Weight:** Install three of the flat Sig lead weights in the weight tip box. Use small pieces of foam rubber or paper towels to insulate the lead weights and keep them from rattling in the box.

**Leadout Position:** Set them in the location shown on the plan for initial flight tests.

**Controls:** They must be free and smooth with equal up and down travel. The controls may look like they are a little slow but they will be fine.

**Balance:** Balance the model at 2" back from the leading edge at the fuselage. This is 16% of the MAC (Mean Aerodynamic Cord). Because of the many different engines that are available today, it is almost impossible for the model to balance properly with every type of engine. To arrive at the proper balance, try using different weight mufflers and/or spinners. Only as a last resort add weight to the front or rear of the model. The prototype balanced perfectly with the OS LA .25 equipped with a stock muffler and an aluminum 1-3/4" spinner from Aero Products.

**NOTE:** Make sure that the wings are warp and twist free and the engine is properly broken in before attempting the first test flight. Double-check everything you can think of before heading for the field.

## Flight Trimming

**Line Length:** Start out with 60' lines from the center of the handle to the center of the model. If the engine is running properly and the lap times are too fast, increase the line length two feet at a time until lap times are in the proper range.

**Handle Spacing:** Set the handle spacing at 3-1/2" between the lines. During the first few flights carefully watch the model in the square maneuvers. If the Primary Force hops when coming out of a square corner then reduce the handle spacing 1/4" at a time until the hop is eliminated. After flying the Primary Force for awhile I found it necessary to increase the line spacing of the handle.

**Lap Times:** The Primary Force should fly between 5.0 and 5.2 lap times depending on which engine you are using. The Fox .35 likes to fly along at about a 5.2 lap time and speeds up slightly during maneuvers (4-2-4 break). Reduce the amount of speed up in the maneuvers with the Fox by using a 10" x 5" prop. The OS LA .25 likes to cook along at 5.0 to 5.2 but the speed in the maneuvers is about the same as the Fox.

**Tip Weight:** With three Sig weights in the weight tip box the outboard wing should drop in a hard corner. Remove one of the weights from the box and cutoff the corners of the weight. Fly the model and see if the wing drops again in a hard corner. If it does, cutoff the corners of another weight and fly again. The Primary Force should pop a turn without any sign of wobble or hop while exiting a square turn. If the model feels soft in the overheads then replace one of the weights with one that does not have corners cutoff and move the leadouts forward 1/8".

**Leadout Position:** As stated in the bench trimming section of these instructions, the position shown on the plan is the place to start and should be really close to the final trim location. Tip weight has a big effect on the position of the leadouts so go easy and move the leadouts slightly ahead if you add tip weight, and slightly to the rear if you remove tip weight. Never move the leadouts more than 1/8" at a time.



**Good Luck and feel free to call or e-mail me if you have any questions and/or comments.**

**Mike Pratt (Mikey)**

**Additional Items Needed:**

**Leading Edges:** (2) 1/2" Square x 36" balsa sticks.  
**Training Edges:** (2) 1/16" x 3" x 36" balsa sheets.  
**Center Section Sheeting:** (2) 1/16" x 3" x 36" balsa sheets.  
**Engine Mounts:** (1) 3/8" x 1/2" x 12" hard maple.  
**Sig 4" Bellcrank:** Part # SH 754.  
**Leadout Cable:** .027" x 6' 7 strand cable.  
**Pushrod:** 3/32" x 36" Music Wire.  
**Sig Nylon Control Horn:** Part # SH 222.  
**Main Wheels:** 1-3/4" Dave Brown Lectra-Lite wheels.  
**Tail Wheel:** 3/4" Du-Bro tail wheel.  
**Fuel Tank:** 3 or 4 ounce uni-flow tank.

**Alternate Method #1:** To add further rigidity to the fuselage, laminate .2 ounce carbon fiber matt between the fuselage sides by using the following method.

- (1) Apply slow drying epoxy to the insides of each fuselage side. Use a squeegee to spread the epoxy evenly over the fuselage sides. Again, using a squeegee remove as much of the epoxy as possible from the fuselage sides.
- (2) Cut a piece of C/F matt slightly larger than the fuselage and place on a piece of Selaflane Wrap or wax paper. Apply slow drying epoxy and spread evenly with squeegee. Again, remove as much of the epoxy as possible.
- (3) Laminate the fuselage sides with the C/F matt between the fuselage sides. Place the fuselage on a flat surface and weights down with old books to firmly press the laminated fuselage together. Allow the epoxy to cure for 24 hours and trim off any excess C/F matt.

**Alternate Method #2:** Use the above procedure and laminated .5 ounce carbon fiber matt between the balsa fuselage and the plywood doublers. This adds a tremendous amount of strength to the front end of the model and helps eliminate engine vibration.