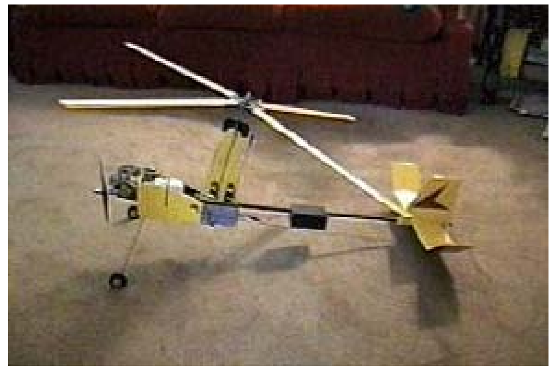
Suitcase Minnie   November 1998

DC-GYRO CONSTRUCTION:

NOTE: These plans incorporate all the small modifications to the original Minnie-1 that proved worthwhile with versions -2 and -3. Technically one could call this version 4, however the changes are hardly noticeable and actually version-1 flew just as well, and the new plan was drawn primarily to simplify and clean up the original and remove some potential confusion in regard to the different rotor hubs that can be used. The new "*flex*" hub is now the primary hub shown, due to its simplicity and ease of construction in comparison to the original mechanically hinged hub. As for flight performance, both seem to perform equally.

The changes from version-1 are simply a slightly reshaped forward fuselage, a simpler battery box, and the new rotor hub featuring a flexible hinge material versus the original model aircraft type hinges.

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1. PRIMARY FUSELAGE CONSTRUCTION:

I recommend you follow these steps in the fuselage construction otherwise you may have problems fitting all the parts together:

(1) Cut out all parts, sand and check for size & fit with each other. The overall length of the fuselage tube is 28 3/4". However do not trim the tube to this length until final assembly and you are certain of the proper rotor to tail fin clearance. See Note #1 below.

(2) Mark the horizontal platform parts for the triangular tube bracing position, and mark & install the engine mount (4x40) blind nuts on F-1. Don't forget or omit this item.

(3) Cut and glue the 1/64 side doublers to the inside of 1/8" balsa fuselage sides. These 1/64" ply side panel doublers are the same size as the side panels. They
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are not shown as having any 'holes' cut in them, however I cut some ½" round lightening holes in them before gluing them in place.

(4) Carefully glue the triangular tube guides to the "*inside"* of the horizontal platforms. See the "X" section depicted just above the forward fuse side drawing.

(5) Glue firewall to one of the sides (only *one* side at this time)

(6) Notch the forward end of bottom platform (*if necessary to clear the blind nuts*) and carefully glue it to the firewall. NOTE: align these pieces very carefully as the firewall must be set for zero degrees side thrust.

(7) Trim the edges of the triangular pieces as necessary on both platform pieces, and carefully glue the top platform piece in place, to the firewall & the side you are working with. Use the tube to align parts, but be careful NOT to glue the tube itself.

(8) Now, carefully glue the other side panel in place, insuring that all pieces are properly aligned. Add the small top nose 1/8" balsa piece.

(9) Install the gear blocks in place, and add triangular firewall braces if desired. The gear blocks are made by <u>modifying</u> the grooved SIG 1/8" gear blocks (SH-655) to accommodate the smaller 3/32 wire. SIG nylon gear straps (SH-131) were used to secure the gear wires.

(10) With the horizontal mid-plates firmly in place, insert the fuse tube all the way forward and drill (from the top) for the forward securing bolt. Glue a blind/wood nut to the bottom of the lower mid-plate for securing the bolt. Harden the holes in the tube and lite ply parts with thin CA glue to minimize fraying, etc.

(11) Before proceeding further, you need complete steps #1 & #2 of the Pylon construction first, and to understand that the pylon is designed to slide forward on the tube, into the slots in the fuselage, and then bolted to the tube. Therefore the slots in the horizontal platforms will need to be trimmed/sanded to accept the pylon snuggly, and aligned vertically to the forward fuse. The slots are purposely drawn slightly undersized to allow for the final fit/trimming. ALSO, note that the forward pylon edges have an aft ½" *jog* in them near the bottom. This jog is there to allow additional room for the installation of the radio in the lower/forward fuselage area. When you proceed to make the bottom balsa panel, remember that the slot begins 1/2" further aft of the slot in the ply platforms.

(12) Using the bottom of the fuselage as a guide, shape the bottom balsa panel, and glue it in place. NOTE: It does not have the *slot* that the ply mid-plates have. After you have completed the basic pylon structure, slip the pylon on the tube, and forward into the slots, trimming the balsa slot as necessary, insuring that the pylon is vertical (90 degrees), and snug fitted to the fuselage. Now, I recommend that you laminate a 1/64" ply doubler piece to bottom to add strength for bracing of the bottom of the pylon. The pylon pieces will slide between the 1/8" balsa strips that are glued *ONLY* to the bottom fuselage plate. These strips add lateral rigidity to the pylon.

(13) The exterior balsa fuselage parts are covered with either Monokote or Ultracote and the lite ply parts such as the pylon is painted with a Testors flat black. You can pick any color you may like, just keep in mind the need for high visibility.

**Note#1: The Carbon fiber tube used for the fuselage (.350 OD, .026 ID) is available from LONE STAR MODELS, Lubbock, TX at 1-800-687-5555 or at their website. Should you elect to use a different rod than the Lone Star tube, be careful that it is (1) light (2) and you adjust during building for any differences in tube size. It is also an acceptable idea to cut lightening holes (about ½" in diameter) spaced around on the 1/64" doublers for the fuselage sides and bottom. This helps to keep the weight down and yet still realize enough strength in the doublers.

2. PYLON CONSTRUCTION:

(1) Complete this from good quality, *UNWARPED LIGHT* ply. Do not cut out for the servos until the pylon is nearly complete. Glue the lite ply stand-off to *one side only*, then place the two sides together and drill for the two upper 2/56 bolts. The pylon is then held together with these bolts, which are separated by the standoff at a width of the fuse' tube.

(2) Glue a couple triangular pieces to the pylon sides as shown on the supplemental plan sheet. These parts hold/align the pylon to the tube. Once this is done, you may return to step 12 of the fuselage construction, if desired, or proceed with the next step here.

(3) The pylon is held in place with two 2/56 bolts securing it to the fuse' tube. First, Insert the tube in the fuselage main body, and bolt the tube in place at the forward bolt. Slide the pylon forward on the tube and into the slots in the fuselage mid-platforms.

(4) With everything aligned (the pylon vertical to the fuselage), drill for the two (pylon to tube) bolts. *See NOTE #2 below. The pylon should extend to the very bottom, flush with the bottom of the lower fuse main plate, in the slots.

(5) If satisfied with the pylon mounting, then use the servos to mark for their cutouts. Small Micro size servos are virtually a must. Anything larger will not fit properly, and will add too much weight. I found the Tower Hobbies TS-11 (Hobbico CS-11; and tower TS-10) will fit perfectly, and with the metal gears (available from Hobbico) installed, they performed very nicely, in addition to being rugged enough to handle the abuse of blade strikes. Hi Tech and Futaba micro servos have been tested on one Minnie and found to perform well also. An excellent (and relatively inexpensive) servo for the throttle is the Hobby Shack [People] CS-20 *Sub-Micro*.

(6) Do not drill the hole for the rotor head pivot shaft until later when specified. The 2/56 pylon to fuselage tube bolts secure the pylon assembly to the fuselage, and permit the ease of removal of the pylon for radio receiver installation as well as packing and travel. I suggest the use of lock nuts, epoxied in place, to insure they do not come loose.

(7) The ply pylon is painted with Testors model paint. I have used flat black and bright yellow on different models. Consider a bright color such as yellow for the high visibility.

3. SERVO MOUNTING:

(1) The pitch & bank servos are mounted in the normal manner on the outside of the left pylon plates. The throttle servo is mounted differently (see the plan sheet). This servo is mounted to the left side pylon plate -before- the plates are placed together. This will place the output arm just to the outside of the right plate. This is done to keep the servo within the sides of the fuselage outline, hiding the servo after the poly-plastic cover is installed.

(2) Cut a small hole in the two mid-plates (see plan) to channel the servo connectors into the lower receiver/switch area.

(3) Fashion a poly-plastic cover (see plan detail "B") from a 1 gallon model fuel jug, and secure with small #2 x 1/4" screws. Cut small holes in the lower rear of the cover for the passage of the receiver antennae, and the battery connector.

4. BATTERY BOX:

(1) A small 270 MAH flat battery pack (Tower Hobbies stock #SANM0913) will be installed in the box which is used to *balance the model*, after everything is complete. *DO NOT* bolt or screw the box in place until balancing is accomplished at the very end of construction. An excellent box for the battery is a Radio Shack "Experimenter's Box" #270-283 (or you may sub a # 270-231) for this purpose. It is much stronger, and probably as light as anything you could build. This box comes with a PC board plate, which is discarded.

(2) Use a Dremel router or heavy pliers to remove the "extra" 2 posts inside the box. Drill the holes for the fuse tube to have the tube fit flush against the plastic box bottom (which is inverted when mounted on the tube). Cut/drill an additional small hole in the front of the box for the battery to switch connector cable.

(3) Thin foam rubber is used to pack the battery, and the metal plate screwed on, after the box is initially slipped on to the tube. Put the box aside until later final assembly.

(4) An excellent battery box can be fashioned from a 4 ounce Sullivan fuel tank. The important thing to remember is to keep the front of the box closed except for the tube passage and battery cable, and use a larger cut-out in the rear to insert the battery. If the front of the Battery box is left open to any extent, the battery will simply *propel* itself right out the front when landing.

5. TAIL CONSTRUCTION:

(1) Cut the tail parts as shown. Use SIG 3" x 3/16" airfoil shaped sheet for the stabilizer if available, to save considerable sanding (see note below). Medium balsa sheet, 1/8" thick, is used for the fin. Be sure to glue 1/64 ply doublers as shown, using epoxy.

(2) Cut/sand and epoxy the Stab tips at a 40 degree angle and apply a thin 1/8" (2" long) piece of Carbon fiber stripping to the top & bottom as shown. The CF strips add tremendous strength to the joint. Use caution to keep the tips straight in line, otherwise they may tend to cause a turn in flight if not straight.

(3) Cover the tail parts with either Monokote, Ultracote, or any equally smooth and lightweight material.

NOTE: The carbon fiber stripping is available from Tower Hobbies or Composite Structures Technology (CST) of Tehachapi, California (800-338-1278). CST refers to this particular striping as *uni-web carbon strips* and/or *tack-on strips*.

(4) The cut-out in the Fin should be just large enough to accommodate the stabilizer. *DO NOT DRILL & BOLT* the tail surfaces until final assembly. We want to insure that the rotor blades will clear the fin by at least 3/4" before bolting the tail feathers in place. When the tail surfaces are installed, *bolt the stab FIRST*... then slide the vertical fin over the stab, align in place, drill & bolt.

NOTE: If you cannot obtain any Sig airfoil sheet material, you can use a flat piece of 3/16 balsa, as long as you sand it down and/or cut some lightening holes to reduce the weight. Be aware that with a flat stab, the model may tend to fly slightly tail low. The advantage of the Sig "lifting" airfoil stab is that it aids more in overcoming the drag of the rotor, as well as allowing the model to fly at a more level attitude.

6. ROTOR CONTROL HEAD:

(1) Study the parts diagrams carefully. We will use only epoxy, except a bit of thin CA (super glue) where specifically mentioned.

(2) The control head (A) will be made of hard 1/4" plywood (do not use lite ply here). Carefully cut the larger "U" shaped part, being sure that the inside cut-out is accurate & smooth. Cut the insert (B) carefully so that it will fit nicely, not too loose, nor at all tight. This piece must be free to pivot within the main part. Once these two parts are cut, clamp them together, flat, for the (3/32") drilling of the lateral pivoting rods (C). It is very difficult to drill completely thru from one end to the other, so I suggest you just drill each end separately. Be careful to align these holes as closely as possible to minimize binding.

(3) Insert two short 3/32 music wires in the pivot holes and check for freedom of movement. You will have to "round off" the top of the inner piece (lower part "A") to permit at least a 10-15 degree of lateral roll. Mark and drill (3/32") for the pitch pivot rod. Note: This hole must align with the lateral pivot rods, and be offset 3/16" forward of the rotor shaft (D). These alignments are important.

(4) Carefully mark & drill (1/8") for the rotor shaft (D). It is important to have this hole aligned vertically, at the center, and be 3/16" offset aft from the pitch pivot rod. Now, using small drills, an Xacto #11 blade, and whatever you can find to work for you, carefully cut out the thin vertical slot for the lateral control arm (E). This arm must fit snuggly (tight).

(5) The control arm (E) was made from 1/16" rigid fiberglass pc board, however hard plywood or hard aluminum should work well also. The small hole on the insertion end is drilled to allow the insertion of a small wire pin, to assist in holding the arm in place along with some epoxy glue. There must be no "play" or looseness in this arm after insertion/gluing.

(6) I recommend you now sleeve the holes you drilled in step (2) above, with pieces of brass tubing. Obtain short pieces of 3/32 ID tubing and then hand-drill the holes (with a 1/8" drill bit) to allow insertion of these sleeves into the main head (top part "A"). Once these sleeves are pushed in, then apply just a slight bit of thin CA glue to the outer edge of the sleeve to secure it to the head. The pivot rods must be free to rotate within the sleeves, with the rods eventually being glued into the lower head block. This “sleeving” of the pivot rods is not absolutely necessary; however it provides a smoother operation and lengthens the operational life of the head.

(7) Sleeve the (3/32”) pitch pivot hole in the same manner as the previous procedure. The pitch pivot rod must be free to move within the sleeve. I feel the sleeving of the pitch pivot rod is necessary to prevent wear and sloppiness of this primary connection.

(8) The top 2/3rds of the rotor shaft (1/8" music wire) will need to be filed and polished slightly in a drill press so that it will move -totally free- within the 1/8" id ball bearings. This is because music wire is slightly "oversized" and will not immediately

fit into the bearings without downsizing the rod slightly. *BE SURE* to complete this rod/bearing fitting ***BEFORE*** you glue the rotor shaft rod into the head block. Cut/file a few small "notches" in the lower 1/2" of the (unpolished part) shaft, and secure the rod in the drilled hole head with epoxy glue. The notches will help hold the rod in the head and also prevent the shaft from rotating.

(9) I painted my finished assembly with a flat black Testors model paint.

7. ROTOR HUBS: (polypropylene hinged)

(1) Drill (13/32") for the main brass bearing sleeve (K) first, in pieces of light 1/8" ply.

Then assuring that the hole is going to be in the center of parts F, G, and I, now complete the exterior cutting of those parts. This assures a much more accurate location of the rotor hub center, which is very important. The brass sleeve (K) needs to be equal in ID as the OD of the bearings being used, which on this model is 3/8" OD. Cut the flexible hinge from Polypropylene material (see note at the end of this subject, below).

NOTE: The blades radiate at 120 degrees from each other, so use caution in cutting the hinge to assure this alignment.

(2) Cut the hole for the sleeve in the hinge and "stack" (align) all the center hub parts together and clamp on one portion while marking and drilling for the three #2 x 1/2" screws (or 2/56 x 1/2" bolts).

(3) Now we disassemble the parts, and after carefully checking alignment and positioning, epoxy the center brass sleeve to the bottom triangle and bottom wood sleeve (I) only. Be sure the sleeve is positioned vertical (90 degrees) to the triangle. The purpose of gluing the sleeve to *only* these parts is to permit the assembly/disassembly of the parts when necessary and yet hold the sleeve in position tightly. After the epoxy is cured, then proceed to the next step.

(4) Glue the top wood sleeve (I) to the top triangle (F), and then re-assemble all of the center hub parts, and secure with the screws (or bolts). Next we can assemble the blade tang pieces (the tang is the part to which the rotor blade is bolted to). Again, be sure the blade tangs align 90 degrees to the sides of the center triangle to insure an accurate 120 degree radiation separation. The bottom (hard ply) piece butts tightly up against the lower triangular center hub piece. This is to prevent/minimize the blade "droop". Note that the top (light ply) tang piece is slightly beveled at the inner end to allow the blade to flap "up" about 10-15 degrees. It is not critical to have all tangs beveled the exact same amount, just be certain that *at least* 10-15 degrees of up flap is available.

(5) Clamp each tang set together on the hinge material, drill and insert the two flat head screws which hold the tang together. Drill for the 2/56 blade mounting bolt using a 5/64 drill. If you have a 2/56 bolt "tap", a good suggestion is to drill this hole with a 1/16" drill, harden the hole with thin CA glue, and then tap the hole for the bolt. This simply aids in keeping the blade more secure with less tendency to become loose. The second (inner) mounting hole is drilled with a larger drill (3/32 to 1/8") and is there to hold a balsa stick *shear* pin. This balsa pin will keep the blade aligned during pre-rotation and should the blade(s) strike anything the pin will shear and prevent/minimize blade damage.

(6) The blades -must- be ***shimmed*** to insure a slight negative true incidence. If not shimmed, and simply mounted flat to the tangs, they will be set for a positive incidence of about 1+ degree, and may not *spin up* before launch. A simple, and very accurate, way to shim the blades is to cut small (3/4" x 1 1/2") pieces from (3 degree size) ERNST thrust plates. These shims can be obtained from **Tower Hobbies,** with a stock # ERNG2000, or ERNG2010, or you may find them at your local Hobby store. A ***workable substitute*** is to cut a 1/8" x 3/4" strip of 1/32" plywood and glue it to the aft edge of the blade tang. This strip is approximately equal to a 3 degree Ernst shim. Sand this shim if necessary to insure no more than 3 degrees of angle relative to the bottom of the flat rotor blade bottom.

(7) I painted my completed hub assembly with a flat black *Testors* model paint.

NOTE: It is important that the 3 degree shims be installed with the thin edge forward, to insure the blade is set for about a 1 to 1.5 degree ***negative*** angle. The blade, if mounted flat, has a **positive** incidence of about 1+ degree, and the 3 degree shim gives the blades an excellent incidence. If you find the blades resist spinning up in a breeze, it may be necessary to increase the negative incidence slightly. Just be aware that the more negative the incidence, the easier to pre-spin, but at a loss of rotor performance. Ideally it is desired to be as close to zero as possible and still be able to pre-spin the rotors. The rotors ***must accelerate into autorotation*** before flight is possible. You can recognize this ***autorotation*** by the rather sudden acceleration of the rotor. Even if your rotor *appears* to be spinning rapidly at the beginning, you can still easily recognize the autorotation acceleration as it is very pronounced.

NOTE: The *Polypropylene* material used is easily found in the house wares department of a local store. The plastic food containers for refrigerator use, manufactured by "Sterilite" of Townsend, MA, are ideal. Look at the bottom of the container for the small recycling triangle symbol and the letters "PP" near by. That triangle may also have a "5" inside it. The important thing is that the "PP" means Polypropylene. You will ***only*** use the flat portion of the ***container lid,*** which may be in a color of blue, green or possibly white. The rest of the container is generally clear in color, and for some reason tends to be a bit brittle and may crack. Wal-Mart, Fred Meyer, and possibly K-Mart, are excellent sources of these containers.

If for some reason you cannot find this material you may substitute the plastic from a heavy duty (3+ lb.) coffee can lid. The coffee can lid plastic will work, but is weaker and almost too flexible. If you must use it, I suggest you monitor the hinge wear and replace the hinge after each 12 flights or so.

8. ROTOR HUB MOUNTING:

(1) The rotor hub assembly is held in place on the rotor shaft (D) by 1/8" wheel collars. You will need to install thrust bearings or at a minimum a nylon washer between the bearings, the sleeve and the collars. This thrust bearing and/or nylon washer must be larger in diameter than the brass sleeve. I suggest you use two collars on the top to insure in hub does not come off in flight. The center of the hub (in line with the blades) should be AT LEAST 1" above the top edge of the control head. If you have installed a long enough shaft, place the center of the hub at 1.5".

The small thrust bearings, between the ball bearings and the wheel collars, help considerably in obtaining a good smooth rotor RPM. In the absence of these thrust bearings, the nylon washers are necessary. An excellent *thrust* bearing is part# A 7 Z 7-012, available from ***Stock Drive Products***, New Hyde Park, NY. Telephone# (516) 328-3300. This is a 1/8" ID (.125) bearing that costs only about $2.50 and is well worth the cost. The nylon washers are available in many hardware stores, and in the large stores such as Home Depot, Eagle, and Home Base.

9. ROTOR BLADES:

(NOTE: You may want to bypass all the work of making your own blades and just order them from AeroBalsa. Order item # 11218RB and just finish them per the following instructions.)

(1) Select a good quality 3/16" sheet of lite to medium balsa 4" x 36", with a uniform grain throughout. By using a uniform weight sheet, it will be far easier to complete all blades equal in weight and a minimum of difficulty in balancing. Mark & cut for the three 15 3/4" x 1 1/2" blades.

(2) Select very straight 1/8" square spruce (or pine) strips for the leading edges. Cut to length, and epoxy to the leading edges of each blade blank. Be sure the blade/strip is held flat against the work table while drying, and that the bottom of the strip is level with the bottom of the blade. Make an airfoil template from cardboard or plastic, and file/sand the blade blanks to shape. It is important to keep all the blades as equal in shape as possible. The more uniform the airfoil the better the performance.

(3) Sand a slight flat edge to the spruce leading edge, just enough to allow for the gluing of the music wire and to maintain a smooth curvature of the leading edge. Cut the wires to length, bend in the "L" hook in each end, drill a thin hole in the spruce LE strips, and using a thin bead of epoxy along the entire leading edge, secure the wires in place. It helps to use strips of scotch tape to hold the wire in place (the glue will not attach to the scotch tape). Run your fingers along the sides of the wire, to smooth out the glue, and then keep the blade flat to the work table while the glue cures.

(4) Cut two 15" (1/8" wide or less) strips of (iron-on) Carbon Fiber for each blade. Mark the strip location at 1/2" from the leading edge, and tack the CF in place with an iron. Then use thin CA glue to secure the CF strips to the blades on both the top & bottom. Using a small piece of waxed paper, keep the strip smooth to the blade when applying the CA.

(5) Cut the mounting pads from 1/64 (bottom) and 1/32 (top) plywood, and epoxy in place, using clamps to insure the top pad conforms to the airfoil curvature. NOTE: Be sure you glue these pads to the correct ends of the blades!! The blades will rotate CCW, and when looking at the blade from the top/rear, the pads will be on the left. After the epoxy is dry, ***carefully*** mark and drill for the mounting bolts & shear pins. These holes "must" be aligned lengthwise (1/2" in from the LE) and spaced properly to fit the holes in the rotor hub tangs. Alignment is necessary to insure the blades radiate 120 degrees apart when mounted to the Hub.

(6) The completed blades are covered with Monokote or Ultracote. I recommend you use a bright color on the top and a dark color on the bottom of the blades.

NOTE: It is highly recommended you obtain & use some carbon fiber strips for the blades and stabilizer. Using such light & strong material insures adequate strength and that your model stays within the flight weight limit. *If* you absolutely cannot find the CF stripping, I would perhaps use a 3/16 square spruce spar down the chord balance/bolt line of the blade to maintain adequate strength in the blade. I *have not* used this type blade on this model, so I cannot say for sure that it will work as well.

10. BLADE BALANCING:

(1) It is very important to fully balance the blades. Each one must balance along the chord line, 1/2" in from the Leading edge. To do this, insert a thin nail, or piece of wire, in the mounting hole at the root end of the blade, and suspend vertically in line with a door frame or something else known to be vertical such as a widow frame. If you've done your work well, the blade leading edge will be fairly well aligned vertically. Check and compare each blade using the same procedure. Its possible that each blade may require a slight amount of weight between the chord line (Carbon Fiber) and the wire leading edge, near the tip of the blade. If the blades are all equal, and are within about a degree of vertical, they should be OK.

(2) Now, the blades must be also balanced spanwise, along their length. Using a small dowel, place a blade perpendicular on the dowel & rotate the dowel to "teeter" the blade to locate the lengthwise balance point of that blade. Do this with each blade and mark the point of balance. Ideally, all blades will balance at the identical point along its length. If any mark is more than 1/8" off from the others, insert/glue a bit of lead weight at the appropriate end of the blade to bring it into balance. Note: insert/glue this weight in line with the chord balance line (1/2' in from LE).

(3) I might mention that an excellent weight to use for insertion/gluing into such small blades is the tiny split lead fishing line weights (about the size of BB's). They are easy to compress/reshape, using pliers, to accommodate a small hole, in the thin blades. Always use epoxy to hold them in place.

(4) If you have used the same sheet of balsa for all the blades, they should all weigh the same, or very near the same. If you have not, then it may be necessary to hold the mounted rotor vertical to the ground and spin the rotor.... noting if it seems to stop on a certain position. If this happens the rotor may vibrate in flight. You may have to insert a small nail in the end of a blade or two to bring the rotor into balance.

(5) Once you have balanced the blades and spin balanced them on the rotor, you can cover them with a material such as Monokote. I highly recommend you use a bright color on the top, and a very dark contrasting color on the bottom. You will find this very important to maintaining orientation of this small model in flight. Heat shrink is ideal for autogyro blades, however these particular blades are so small & fragile, that heat shrink will tend to "crush" the blade, therefore shrink is not recommended.

11. MISCELLANEOUS:

(1) Shape the landing gear struts form 3/32 music wire, and use small lightweight wheels. Since this model is hand launched, it is needless to use large wheels, and the object is to keep the weight low. I found the Williams Bros. 1 7/8" (Vintage wheels #128) to be usable, along with Dave Brown Lite Flite, and small pylon racer wheels. The most practical is Dave Brown 1.5" lite Flite.

(2) The engine used on the original model, which I found to work very nicely, was the Thunder Tiger GP.15, with a Master Airscrew (glass-filled) 8 x 4 propeller. The

OS .15fp works equally well. The engine is mounted to a Dave Brown (#1519) mount, using 2/56 bolts threaded into the mount. Mount the engine up-right and cross check that you have zero degrees side, and 5 degrees downthrust. Note: the zero degrees side thrust is important, be certain that this is correct. *I have also mounted the engine tilted 45 degrees to the right,* to help limit fuel exhaust problems. This *side tilt* did not seem to bother the side balance of the model and worked fine. The fuel cell is a DuBro, 2 ounce, rectangular. This tank is held in place buy a rubber band secured to 2 small dowel pins glued into the sides of the fuselage.

(3) Servo pushrods. Use regular 2/56 rods, and secure the rods to the servos with a 90 degree bend and small wheel collar. At the lateral/bank arm connection use a small nylon or metal klevis. The Pitch rod is secured to the AFT 3/32 music wire control rod (on the head) with a DuBro (#2135) 2/56 Swivel ball link. This link is located and held in place on the rod with small wheel collars on each side. Note that this is the type link used on helicopters, do ***not*** use the normal nylon pop-on/off ball link. For the throttle cable connection, use your favorite... however remember to keep it light. I used Sullivan golden rod.

NOTE: It is possible to strip the gears of a servo if the rotor blades are permitted to strike the ground, etc., at any time while in motion, and you do not use the balsa shear pins. You can obtain the metal gears for some of the micro servos (Tower Hobbies TS-11 with Hobbico gears #HCAM1059, or Hobbico servo CS-11 with those gears) to minimize this problem. Another approach would to just use the standard nylon gears, and install model car "servo savers" sold by KP (Kimbrough Products). The blades are mounted with a 2/56 bolt and a 1/8" square balsa stick used as a shear pin.

(4) The receiver was installed in the lower forward section of the fuselage. I have used ACE Micro Pro receivers with pigtail connections, the standard (small) JR, and the new FMA receivers all equally well. The smaller & lighter the receiver, the better. Without some modifications to the fuselage bottom, you will probably need a receiver with either pigtails that exit the end of the receiver, or one of the above with the connections that fit directly into the end of the receiver. Ideally, the JR, and FMA's are the perfect size/shape receiver for a model such as this. To avoid the problem of housing a bulky (standard) receiver switch, I built my own harness using a radio shack sub-mini slide switch (# RS 275-407), and mounted this switch in the area marked on the plans, just forward/left of the pylon. Do not use a charge mount -- it is too bulky -- simply leave the charge pigtail extend through the plastic fuse cover. You may also just want to use the connection to the battery box as a charge plug. The important thing to remember is to ***use small lightweight items.***

(5) Tail Skid. A music wire of approximately .035" to .045" size works well for a skid that projects down 1" to 2". See the drawing on the plans and apply these instructions for completing the skid. Cut and drill the dowel for the wire using. Slot the ends as shown. Using a 5 to 6" wire, bend in the short hook on one end. Insert the wire into the dowel, pull the wire thru until the small hook is seated into the slot. Then bend the wire for the first vertical segment, making sure the wire fits snugly into both ends of the dowel. Complete the bends, making sure the front vertical part extends about 1/8" forward and 1/4" above the front of the dowel. The front vertical part will fit into a hole drilled vertically in the tube just aft of the stabilizer. To insert the

skid assembly, slide the dowel into the tube, and by "bowing" the wire, insert the front vertical of the wire up into the small hole aft of the stab. The dowel should extend aft of the tube approximately 1/4". To remove/repair the skid, simply pull the front wire down/out of the tube and slide the dowel aft.

(6) I found that a clear shield, fashioned from a thin sheet of canopy acetate, and secured to the pylon with small screws and the 2/56 stand-off bolts, aided in keeping fuel/oil off the servos. See plan detail “C”. This is an optional item, but highly recommended. Without an exhaust extension, or tilted engine, fuel exhaust may tend to accumulate on the servo bottoms and right pylon side

(7) The fuselage tube will “bow” slightly if you land the model too firmly (a likely problem with learning), and rotor striking is possible on the fin or fuse tube – ***Not*** because the rotor blades dropped and struck the model, but because the fuse’ tube ***flexed upward***. If this becomes a real problem for you, and the model is well within the 30-32 ounce weight area, you may want to insert a 1/4" balsa stick in the tube. This will not add much weight, yet should provide some rigidity and reduce this flex. It will be necessary to sand the edges of the 1/4 stick in able to insert it all the way into the tube. <u>I would ***recommend*** that you go ahead and install this stick in the tube during the building phase, and thus allow yourself some damage avoidance protection</u>.

(8) The fuel tank is held in place by a rubber band secured to each side of the fuse by small wooden (1/16") dowels.

(9) If you have never worked with Carbon Fiber tubing, use ***reasonable caution*** in its handling. You can avoid sloppiness in your bolt connections by drilling for a snug bolt fit, harden the hole with thin CA, and then use a bolt "tap" to create some threads in the tube. All the bolt connections to the tube should be completed ***one at a time***. In the situation of two bolts holding an object (like the fin), clamp the fin in alignment and then drill and insert the first bolt. ***Recheck*** the alignment, and ***then drill*** for the second bolt. Sometimes, when the first bolt is way off... "overcorrect" for the second bolt hole so that the final alignment is correct.

(10) Use CA glue for the 1/4" triangular (tube alignment) pieces on the fuse sides and pylon sides. Mark the surface, wrap the tube in wax paper, hold the tube in place, and slide the triangular balsa in place, and zap with CA. The wax paper prevents you from gluing the tube to the parts.

11. BALANCING AND FLYING:

(1) BEFORE securing the battery box by a screw or bolt, hold the model up by the rotor hub. Slide the battery box fore/aft on the tube until the model hangs nose down at 7° (5° to 10°) nose-down attitude (know commonly as the "hang angle"). Once you have the correct angle, then hand drill a small hole through the box plate into the tube, and secure with a #2 screw or 2-56 bolt. Do this with the fuel tank empty... Adjust the fore/aft tilt to allow the rotor to be flat/level with the model in the forward position, and spin no closer than 1 inch from the tail boom in the aft position. The lateral (left/right) tilt of the rotor should be set for 7 degrees each direction. Then, if you have completed your work well, the model should weigh no more than 30 ounces. More than 30 ounces, the performance may be poor, especially if your flight field altitude is over 2000' in elevation.

(2) Test the rotor for lateral trim that may be necessary for flight by holding the model with the right hand, just below & forward of the pylon, at a nose high (45

degree angle). Point the nose directly into a breeze, lightly flip-start the blades with the left hand, and if the breeze is sufficient (5k or more) the rotor should slowly accelerate or at least continue to rotate at a moderate rpm. If the breeze is not strong enough to accelerate the rotor automatically, walk slowly into the breeze, maintaining the nose high attitude. The rotor should then accelerate into autorotation.

When you notice this sudden and noticeably high speed RPM, slowly lower the nose to perhaps only 20-30 degrees nose high, while maintaining the high rpm. Now, the model will gain lift and become very light. At this time note any tendency for the model to pull/lift to the right or left. If you do not notice any unusual tendency, then leave the lateral trim zero (disk level left/right) for launch. It would not be unusual for a model of this configuration to lift slightly to the right, requiring a couple degrees left pre-tilt trim in the rotor for launch, however most of the Minnie models have zero left/right trim requirements. I doubt if you will ever get a left lift requiring right tilt trim... if you do, re-test to make certain. Make a paper template marked for 12-13 degrees of aft tilt, and set the disk for a pre-launch pitch trim of +12-13 degrees (disk tilted aft). This will usually place the blades aligned about 1" below the front tip of the vertical fin. Forward tilt limit should be sufficient to basically "level" the disk with the fuse' tube, while aft tilt should be limited to no closer than about 2" above the fuse tube in the full aft stick position.

(3) Set the lateral (left/right) throws to allow 7-10 degrees tilt each direction. You will find that the model will react quite well with the 10 degrees, and anything in excess of that will make the model highly "sensitive" and promote over-controlling. If the model experiences *any* problems completing a turn, it will almost always be when attempting a ***right*** turn. This when the turn is ***into*** the advancing blade. Your final control throw settings may require a little more right throw than left.

(4) Set the throttle trim so that you can virtually stop the engine with full down trim. Maintaining a 'high' idle trim may make it difficult to land the model under zero to light wind conditions, therefore you need to be able to slow/stop the engine as soon as possible after landing.

(5) For launch, start the engine and walk to a position up wind where you can point the nose into the wind, and be able to walk into the wind perhaps 30-50 feet if necessary.

CAUTION: Always launch directly into a breeze! A cross wind launch may cause the model to roll to the side before you have the chance to correct. The model will fly in a strong wind over 10 kts; however AVOID THIS as it may make it ***difficult*** *to* land without damaging the blades due to the wind blowing the model over after/during the landing. Don't attempt to taxi this model, it has no tail wheel, and it can easily blow over with cross-wind.

(6) Try to keep the model within 2-300' and watch it closely. Orientation with a wingless gyro can be difficult, and it is recommended you have a helper at least for the initial few flights. I color the top of my rotor blades a bright color, and attempt to keep the bright disk top in view. This tells me the model is not *going away*. If you allow the model to get too far a way, orientation -will- be quickly lost and flying impossible. **IF ORIENTATION OR CONTROL IS LOST, first reduce the power! Second, release/neutralize the control stick and allow the model to stabilize itself.** You may then be able to re-orientate yourself and continue to fly it. If not, throttle off and allow the model to settle by itself.

(7) With power failure, you will still have some limited control (depending on altitude). If at low altitude, it is best to release/neutralize the stick, and allow the model to settle like a parachute. Generally it will sustain only a broken propeller / bent landing gear/ and or a nicked rotor blade or two.

(8) Landing: **Approach into the wind!** Slowly reduce altitude & power as you approach the desired landing spot. With practice you can land at your feet with zero ground roll. Do not allow the nose to get too high too soon... the ideal landing is when you can reach a few inches above the surface with the nose slightly high and at or near zero airspeed. If you find yourself drifting crosswind during the final portion of the approach, it is best to abort the landing and try again. Without a rudder, it is *very* difficult to correct for the drift with rotor tilt only.

(Update 11-98a)

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