DRUINE TURBULENT
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Construction Notes
1:5 Scale

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The Turbulent was a popular home built plane in the fifties and sixties. Of wooden construction, it was designed in France and considered to be a relatively easy scratch build. The wing span is 21 feet 6 inches and at first it used a 25 h.p. Volkswagen engine. The performance was enhanced considerably when the 1200 cc VW engine was introduced producing 36 h.p. Even with the 1200 cc engine, the climb rate on a hot day with a heavy pilot was not very impressive, but it could cruise at a healthy 90 m.p.h. and go a long way on a gallon of gasoline.

The design of the Turbulent lends itself to an easy build for a model, and could be a good choice for a first time scratch builder. With generous dihedral, it is very stable, making it a great aileron trainer. An added advantage is that being quite aerobatic; it is more fun to fly than a model that just flies around in circles. With a Park 450 motor it will pretty well climb vertical. A Park 400 motor would be quite adequate for anything but aggressive aerobatics.

This is the third Ivan designed Turbulent, the first one in the glow powered days prior to electrics and the second one electric, but before plans were published. Great memories of the delightful handling qualities of the earlier models led to the design of the present easy build model. Both of the earlier models were flown at times on floats and proved to be very suitable for water flying.

The battery can be changed without removing the wing and is accessible without hands being close to the arc of the propeller in the case of an inadvertent start up.

A thin airfoil and light wing loading results in a slow flat glide, and makes for an easy transition to flare and soft touchdown.

Druine Turbulent. August 2016. Scale 1:5. Span 50.3 inches; wing area 406 sq. ins. Length 40 ins. Motor, Park 450- 890 KV. Prop 10 x 7. Battery 3S Li-Po 1600 mAH. Flying weight 28.2 ounces, Wing loading 10 oz/sq.ft.

FUSELAGE CONSTRUCTION

The fuselage has 1/16" sheet balsa sides. The top is rounded and sheeted with 1/16" balsa. It is not necessary to make a stick framework though some builders may prefer to do that in the traditional manner by assembling the sides over the shaded longerons and vertical cross pieces. Assembly has been found to be easier by cutting out the sheet sides first, then gluing the longerons and vertical cross pieces in place before assembling the two sides.

Note that the datum line is the top edge of the longeron that runs the full length of the fuselage at the top edge of each side piece. The square box section of the fuselage below the datum line is built first, and the curved up section added later. If using 3 inch wide sheet balsa to make the side pieces, it will be necessary to glue an additional 1 1/2 inch wide strip of 1/16" sheet to a 3" wide sheet to give the 4 1/2" wide piece of sheet necessary for each fuselage side. Each side should be cut to the outer edge of the shaded longerons and end sticks. The upper and lower longerons running lengthwise are now glued to the sides These strips will be on the inside of the fuselage, so be sure to make two opposite sides. We don't want two "left" sides. Gluing these strips to the edge of the sheet brings up the topic of what kind of glue to use. While CA is a wonder glue, it does not need to be used for everything. It does not always make a good join, especially on end grain, does not dry out light, does not stick well to some plywood, is difficult to sand and is expensive. Carpenter Glue is very suitable for this type of construction, especially the cream or tan coloured kind that goes by the name of aliphatic glue. It allows time to get the sticks in the correct place, and dries out very light. It is not as brittle as CA and seems to result in less cracks. Besides, the joint can be glued a second time if a repair is necessary. If you buy some small clamps at the dollar store they are great for gluing sticks to sheet like this, or you can pin them together on the bench. If you must use CA, try the combination. Use a bead of carpenter glue along the length of the joint, but not at a point where a pin would be attached if you were pinning the sticks to the sheet. Put one drop of CA glue where a pin would be located. When the strips are place on the sheet in the correct position, press on the spots where the drops of CA are located and they hold the pieces together while the carpenter glue dries. It does not matter if the glue squeezes towards the drop of CA glue and mixes with it. Carpenter glue is water based, and the water content is like an accelerator to the CA. If carpenter glue is smeared lightly before placing the pieces together it does not take too long to dry. Meanwhile other parts of the construction can be continued.

The vertical cross pieces are then glued in place, and the wing saddle. Most of the vertical sticks (cross pieces) are 1/8" square, but the ones at the nose and tail are wider. Note the vertical cross piece near the leading edge that bulkhead B2 will be attached to. It runs from the upper longeron at the top, right to the bottom longeron. The length is 3 7/8 inch. The hatch lines on the plan that extend upwards on this stick ¾ inch from the bottom are indicating the depth of the 3¼ x 3/4 x 1/8 doubler that will be glued across the bottom of B2. At this point the five 1/8" sheet gussets are glued in place. Note that G2 is a full triangle as shown near the bottom of the plan. Be sure that G4 at the tail is a good fit and glued well.

When these two side pieces are finished, they are assembled by placing them upside down over the top view of the plan. Start by gluing the bulkheads B2 and B3 in place. Bulkhead B2 has a doubler across the bottom with a hole in it for the wing dowel. It is best to leave drilling this hole until fitting the wing so that it is in the correct position. Glue bulkheads B2 and B3 firmly to the adjoining vertical cross pieces. Small spring clamps make this task easy. The two sides are now joined at the tail. Notice that there is a small spacer between these two sides at the tail so that the overall width of the fuselage at this point is the same as the width of the fin spar (rudder post) shown at the right hand edge of the plan.

The 1/8" ply motor mount, B1, is now glued in place. It is best to drill the large hole and four small ones in B1 before installing it. If you wish to build in a little right thrust for the motor, (recommended) the small holes for the screws securing the motor to the ply motor mount should be offset about 1/8" to the Port (left) side of B1. When this is done, glue bulkhead B1 in place to the rear surface of the vertical stick at the nose. Another detail about the optional right thrust, is that if doing this, the width of the vertical 1/8"x 7/16" stick at the nose should be increased by 1/8 inch to a width of 9/16" on the starboard (right) side. These changes are necessary in order to keep the prop shaft in the center of the nose where it exits the nose block. The alternate method of giving right thrust is to add a shim of plywood behind the motor mount lugs on the left side.

The upper rear bulkheads T4 to T9 are next glued in place along with the corresponding 1/8" square crosspieces at the bottom. Attach the three stringers that run from T4 to T9, and sheet this upper surface with 1/16" balsa. Select softer balsa for the curved part at the top. If the outer surface is dampened it helps to make the curve without splitting the wood.

Now attach bulkheads T2 and T3 and sheet as indicated from B2 to a point a little to the rear of B3. Do not attach the bulkhead T1 to the nose. It is part of the removable battery hatch which will be built later. The sheeting across the bottom of the fuselage forward of the wing is now glued in place, leaving a gap as shown for cooling air to exit. It is not necessary to sheet the bottom of the fuselage rear of the wing trailing edge. The piece of 3/16" spruce that holds the wing screws at the trailing edge should now be glued in place. If using ply, 1/8" thickness would be sufficient.

The nose block is now made. It can be shaped from four laminations of 1/4" soft balsa. Note that the inner hole is enlarged as it goes back to where it meets the airframe. This makes motor installation easier, since it is inserted through this hole when mounting. If the bottom lugs of the motor mount go through the opening in the nose block first with the motor angled slightly down, it will be possible to get the motor into place if the opening in the nose block is large enough. If it is not possible to line up the screw driver with the mounting screws, file a grove in the nose block. This will not be seen when the spinner is in place. Robertson screws (with a square hole for the square screw driver) make mounting much easier in a situation like this, since the screws are easy to keep in place on the end of the screw driver. A good size screw for mounting like this is #4x 1/2".

With the nose block attached, the battery hatch can be built. Start by making bulkhead B1 and drilling the hole for the locating dowel, also of course drilling the hole in the nose block that this dowel goes into. Make another bulkhead B2 and build the hatch in place, separating it from the airframe with a piece of cling wrap, very thin plastic sheet. This prevents the hatch being glued to the airframe. If using the simple catch shown in the plan to secure the rear end of the hatch, be sure to have a piece of plywood in the fuselage that the screw goes into. Balsa will not hold. There are other options for securing a hatch like this, such as small magnets.

A 1/16" sheet balsa plate is attached to the lower surface of the upper longerons in the area of the cockpit. This adds rigidity to the fuselage and serves to mount the pilot; a must in this model.

The undercarriage design shown was used for years by kit makers, but some builders may have other options. Since one landing gear leg is slightly ahead of the other where they cross the bottom of the fuselage, an adjustment has to be made to one of the (rear) plywood anchor supports. *On one side of the fuselage, the width of the rear plywood anchor needs to be increased by the diameter of the landing gear leg. The plan shows a 1/16" wire strut sloping upwards and forward from the wheel location. This strut does not need to be piano wire. Regular wire like spoke wire is easier to work with and solder. The strut is necessary if the main U/C legs are made from 3/32" wire. Without this strut, the main legs flex backwards when taxiing in grass and this can result in the model going on its nose. Another option is to make the gear legs of 1/8 wire" in which case the forward sloping strut should not be necessary.

Start building the tail surfaces by cutting the spars and shaping them to match, fin spar to rudder spar, and likewise stabilizer to elevator. The slots of the hinges are cut at this time and hinges installed temporarily to check for alignment of the surfaces. The tail surfaces can now be built over the plan. Because the fin is tapered, be careful not to get a warp in it. An optional way to build the fin is to attach the fin spar to the fuselage first. Then make the leading edge of the fin and tip, join them together, and glue them in place on the fuselage. To complete the fin, fit the ribs and sheet the section joining the fuselage. The dorsal fin can now be attached to the leading edge of the fin, running a short distance forward along the top of the fuselage.

The method for attaching the tail wheel is not scale, but is very easy to build and helps greatly with turning on the ground. Most Turbulents had a tail skid, but one well publicized full scale Turbulent in Switzerland, HB-SVB, had a tail wheel and I believe was fitted with brakes. The standard tail skid on most home built Turbulents did not extend for below the rudder, and unless the builder is a scale purist, I do not recommend the short scale tail skid. A small change in the length and angle of a tail skid can make a huge difference to the way a model lands. Single engine tail draggers of years ago almost always did three point landings, and this is the safest way to land a model like this. But as modellers, the problem we have is with small airfoils in the size that we use in our models. A small airfoil stalls at a much lower angle of attack than a large one in a full scale plane. In full scale aircraft the stall angle of attack of the wing can be in the range of 15 to 17 degrees, but in small models it is usually from 10 to 12 degrees. When a tail dragger sits on the ground, the angle of attack of the wing should not be greater than the stall angle. Therefore a few things in the design of a model tail dragger have to be done if we want to be able to do smooth three point landing. One is too make the tail skid longer than scale. It reduces the angle of attack of the wing, and also keeps the bottom of the rudder out of the grass on the typical grass flying field. Whether you choose to use a tail wheel or tail skid on your model Turbulent is not important, but either way, be certain that the bottom of the rudder is no less than 2 inches from the ground when the plane is at rest. If the tail skid is too short, the main wheels will touch the ground before the tail skid, the tail will drop, and the resulting increase in angle of attack will lift the plane into the air again at least once, if not several times.

By all means keep the tail section light. You cannot fly a tail heavy model safely and we want to avoid having to add dead weight to the nose of the model to balance it. Fortunately with electric models, the way to go when the tail is heavy is to use a larger capacity battery up front. The advantage of this is an increase in flight duration.

With the control horns attached, and the stab and elevator pinned temporarily in place, this is a good time to install the servos and pushrods for the tail surfaces. Keep the control rods as straight as possible to reduce bowing and friction, and be sure to brace them as shown at bulkhead 3 and station 7.

WING CONSTRUCTION

It is important in building a wing that there is no difference in the incidence of one wing from the other. This sometimes happens because the wings are built separately, and the error creeps in when they are joined in the middle. If the spars are cut as shown in the plan and joined along the overlapping splice line before starting to assemble the wing, there is a better possibility of not having a twist in the centre section. After cutting the spars, make the ribs. All the ribs are 1/16th balsa except the center one which is 1/8". These are cut to the outer outline of the airfoil. Next cut the notches for the upper and lower main spars. Because 1/16” sheet is attached to these spars, the notch in the ribs needs to be 1/16" deeper than the thickness of the spar. Next trim 1/16” off the top and bottom edge of the forward section of the ribs from the spar notch to the leading edge. This can be done very easily with a simple balsa stripper made by Master Airscrews, a good $6.00 investment for any scratch builder. Note that the three ribs in the center section are also sheeted from the spar to the trailing edges, so the rear part of these ribs needs to be trimmed also to allow for the thickness of the sheeting. The two ribs in each wing panel that support the rails for mounting the aileron servos also need to be notched along the bottom edge for the rails.

A secondary spar 5/16” x ¼” that supports the aileron hinges is cut and shaped from ¼” sheet balsa and runs the full length of the wing. To assemble the first wing panel, pin one of the secondary spars to the plan laid out on the building board. Now pin the bottom spar for the same wing in place, with the attached spar for the other wing panel propped up 3 inches because of the dihedral angle. Note that this spar is going to have sheet covering, so a few strips of 1/16” balsa scrap should be used as spacers to keep the bottom of the main spar 1/16” inch about the surface of the building board. Now glue all the ribs in place except the ones for the centre section which will be added later. Check that the lower edges of the ribs between the spar and trailing edge are flush with the surface of the building board.

Notice that the leading edge is made of two strips of balsa 1/8" thick. The first strip, or inner one, is 1/4" wide and the second one 5/16" wide. These can be cut from 1/8" sheet. The inner strip is now glued to the nose of the ribs. There is a cut out in the leading edge of the wing at the centre section, but temporarily it is best to continue this leading edge strip right to the centerline of the wing. Doing this again when building the other wing panel ensures that the leading edges are lined up perfectly where they meet at the center, something that is very important. The short trailing edge from the centerline of the wing the where the aileron starts can now be attached to the rear of the secondary spar. This can be cut to length from 1¼” x ¼” aileron stock. If this is not available, it can be shaped from 1/4” soft sheet. The ailerons will be made in like manner later on. When the glue is dry, remove this wing panel from the board and prop up the tip 3 inches so that the spar of the other wing is resting on the plan. Pin the spar in place.

Repeat the process for assembling the second wing panel. Start by joining the two rear spars with the 1/8" ply or spruce doubler, being careful to centre it so as to allow for the inset sheeting that will come later. When attaching the inner leading edge strip of the wing, make sure it lines up with the leading edge of the first panel that was built.

The upper wing spar is now glued into the notches in the upper surface of the ribs. The ply doubler that strengthens the center section of the wing is next glued into place on the rear surface of the spars. This glue joint is very critical. Smear carpenter glue into each face before the doubler is attached to the spars, and clamp well. The rear part of the three center section ribs can now be glued in place. The ribs are cut where they meet up with the double on the rear of the wing spar and the rear sections of the ribs are glued in place first. Before gluing the front section of the three remaining ribs into place, you might try a trial fit of the wing to see if the placement of the two nose ribs adjacent to the side of the fuselage is going to be correct. The spacing between them should be the same as the width of the fuselage. Mark where the inner end of the leading edge will be cut off just clear of the side of the fuselage, and glue these two nose ribs in place at this mark. Now attach the 1/8" doubler to the front surface of the wing spars. The 3/16" front mount that holds the wing dowel is next glued in place between the two nose ribs and secured firmly with the 3/16" gussets shown. The wing dowel is now glued in place. Next the remaining 1/8" nose rib is sliced lengthwise and trimmed so the upper and lower sections can be glued to the top and bottom of the wing dowel.

Now glue the four 1/16" web plates of each wing panel in place to the rear surface of the spars as shown. Note that the grain should be vertical. It is not necessary to do these to the last two wing bays. The web plates along with the sheeting top and bottom from the leading edge to the main spar form what is called a "D" section. It is like a hollow tube that is very resistant to twisting. Without these webs, when full aileron is applied at high speed such as doing a roll, the upward or downward force on the trailing edge my cause the wing to twist. Furthermore, this twist is in the wrong direction in regard to producing the desired direction of roll. In mild cases, this twisting of the wing reduces the effectiveness of the ailerons. In extreme cases it can even cause what is known as "control reversal." This used to happen in the early days of supersonic flight when flying surfaces were not rigid enough.

The wing tips can be added next, or left until sheeting of the wing is completed. The bottom surface of the wing is now sheeted from the leading edge (just the inner strip in place so far) to the main spar. The only part rear of the spar that is sheeted is the center section of the wing.

Notice at this point that the wing can still be easily twisted (warped). The "D" section has not been closed since the top sheeting is still to be applied. After the top sheeting is applied it will be quite rigid, so it is very important that the wing is held in place while the top sheeting is glued on. Each wing panel should be very straight with no twist from the center section to a point about half way out to the tip. From this mid point in the wing panel to the tip there should be a slight twist which is called washout. To do this, put weights on the top of the first wing panel that is to be sheeted, but just from the centre section out to midpoint of the wing. These weights can be placed on top of the ribs just to the rear of the spar. Now put a 3/16" spacer under the end of the secondary spar at the point shown (*) on the plan near the tip, and weight down the leading edge at the tip so that the wing is twisted slightly. This ensures that the twist is correct while the sheeting is glued to the top surface of the wing panel. Again, instead of using pins to hold the sheeting in place while the glue dries, the CA / carpenter glue combination works well. When cutting this sheeting, it is best to have it slightly wider than necessary so that a little extends over the edge of the (inner) leading edge. When the glue dries, remove the weights and notice how difficult it is to twist the wing. Now trim the sheeting flush with the font face of the leading edge strip. The leading edge is completed by gluing the second (outer) strip to the first one, cutting to the dimensions shown on the plan. This is now sanded to a nice round section.

Sheeting is now added to the top surface of the other wing panel, and outer leading edge added. The remaining part of the center section of the wing can now be sheeted both top and bottom. The wing tips are completed by sheeting top and bottom from the leading edge to the spar line.

Ailerons are cut and hinged. They can be attached before or after the wings are covered. The method shown for mounting the servos is possibly the simplest way of mounting the servos. More experienced builders may choose to install them flat in the wing. That is better, but requires a little more work. Two things are important in the aileron linkage in order to give adequate differential aileron. The control arm of the servo should sweep forward as shown on the plan when in the neutral position. The second item is the placement of the control horn on the aileron. It should not be up close to the hinge line. That is OK for the rudder and elevator, but with the aileron it should be back towards the middle of the aileron. For those who want their model to be true scale, in the full size Turbulent the aileron hinge line went right to the tip of the wing and the last part of the aileron formed part of the wing tip. They are actually easier to build that way, but the advantage of building the tip as shown in the plan is that, when the aileron stops short of the tip, the model is less prone to the dreaded tip stall. And believe me, speaking from first hand experience, the full scale Turbulent had very vicious stall characteristics. In order to tame the tendency for tip stall in the home built Turbulent, (anti stall) slots were built into the leading edge in the outboard sections of each wing. Besides being difficult to build accurately in a model, these slots are not necessary in this model if the wing is built as designed and has the correct washout. In a full scale plane, washout is kept to a minimum because it has a penalty when it comes to cruise speed, but that is not so important in a model.

When making the hole for the wing dowel in the doubler at the bottom of bulkhead B2, start by making it a little too high, then filing out the bottom until the wing is a snug fit. Having the hole a little larger on the top edge makes it easier to put the wing on and take off

The centre of gravity is shown on the plan. It is very important that you are close to this. Adjustments are made by changing the battery position, preferably using a battery of larger capacity if the model needs added weight in the nose. Control throws are shown on the plan. These are important. A good flying model is always the result of paying attention to details along the way. Get it right the first time.

There you have it. Enjoy building and flying this great little model.

Ivan