

# A Douglas DC-3

Here's a large, slow and gentle airplane that's a twin-builders dream for Stand-Off Scale. All it needs is an eight foot wing, two .45's and all your balsa/**Tony Lombardo**

**B**ack in 1959, while on a business trip, I booked a flight on a local airline in the South. That was the only time I had ever flown in a DC-3. Ever since that flight the DC-3 has been tucked away far back in my mind. I thought that "someday I'll build a flying model of her". Since I got started in radio control aircraft the desire to attack the project became stronger, but I held off mainly because of the problems I believed I would have with a multi-engined ship. Finally I gained the experience (and the two engines) to start the project.

I believe that the larger models are easier to handle, so after some research, which was mainly sizing up my Vega station wagon, I settled on a scale of one inch to the foot, so I would be able to just fit the ship into my diminutive wagon. At this scale the DC-3 model sizes out to 95 inches.

Building such a large aircraft is a big job, but planning and designing it can be a task also. With such a large investment in balsa,

spruce and engines I wanted to be certain that the ship would be a successful flyer. With this in mind I enlisted the help of several friends and fellow modelers.

Joe and Vincent Sardi enthusiastically agreed to help me develop the drawings as well as research the geometry. Being excellent modelers, in their own right, as well as designers at the Grumman Aircraft Company; their help and cooperation resulted in a fine set of plans.

Two other Grumman engineers, and fellow Brentwood Airmasters members, agreed to help. Hank Stumph developed the airfoil sections and Frank Dellamura ran a lift/drag check to determine the ship's potential flying qualities and required engine size. Frank was also of great help in preparing the article and photographs. He was around to help, advise or just be there when I had to bounce an idea off someone in order to think it through.

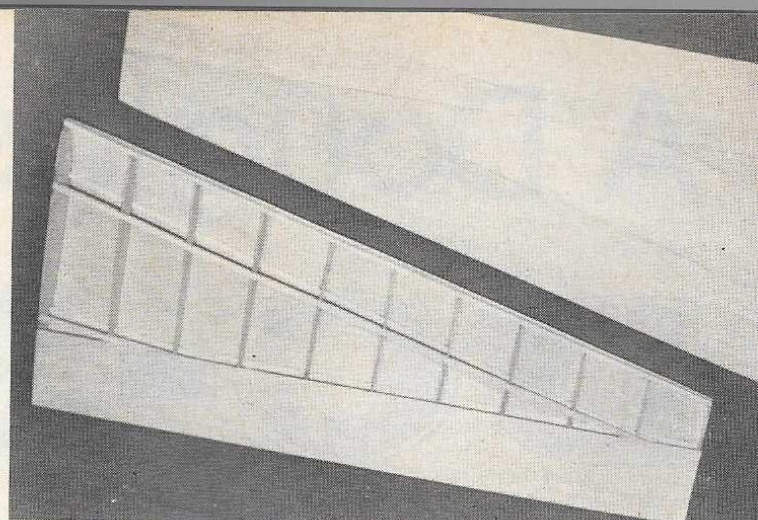
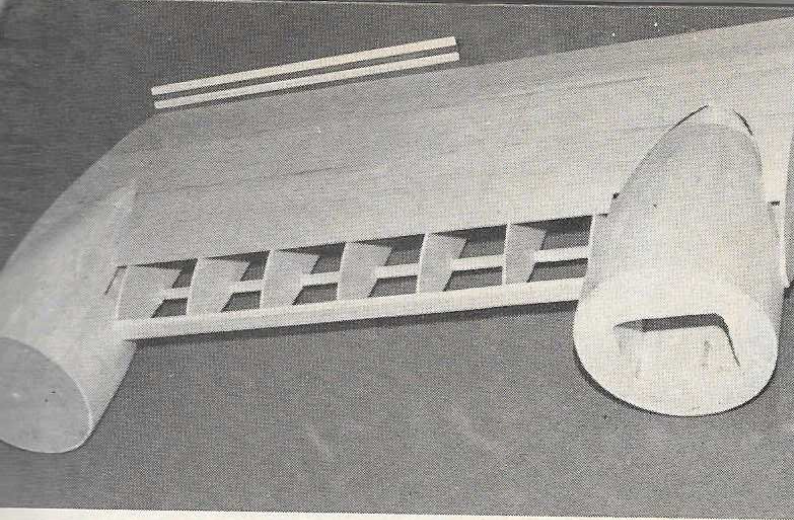
All of this assistance allowed me to con-

centrate on the task of building and finishing the ship. The project was, therefore, a team effort which greatly reduced the time it would take to build such a model. From the first slice of balsa to the initial flight took seven weeks.

As most of you know the DC-3 is the airplane most responsible for the development of safe and cheap air travel. American Airlines first contacted Douglas, in 1935, requesting an airliner designed for sleeper service. Douglas had been building the DC-2 and selling them with limited success. The DC-3 was a modification of the DC-2. It had a larger wing and fuselage with more powerful engines. It was originally known as the DST (Douglas Sleeper Transport). The DC-3 (DST) flew in late 1935 and was delivered to American Airlines in 1936. It was such a phenomenal success that orders flooded into Douglas from airline companies all over the world. By 1938 Douglas had delivered 350 DC-3's at \$100,000 each!

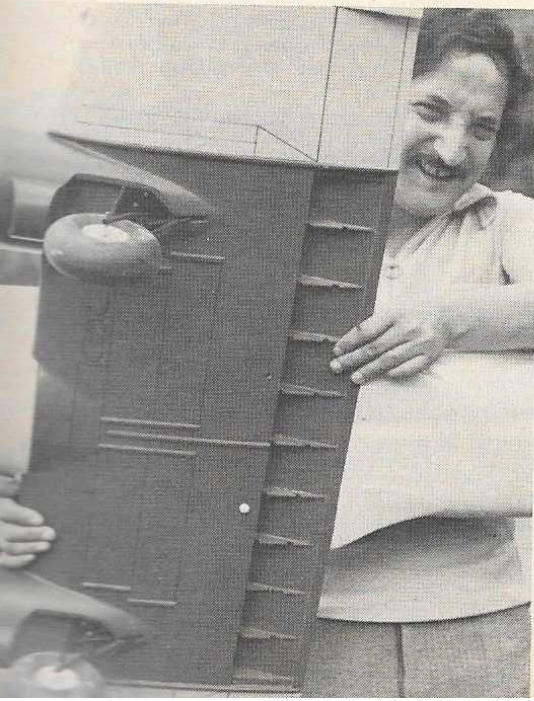
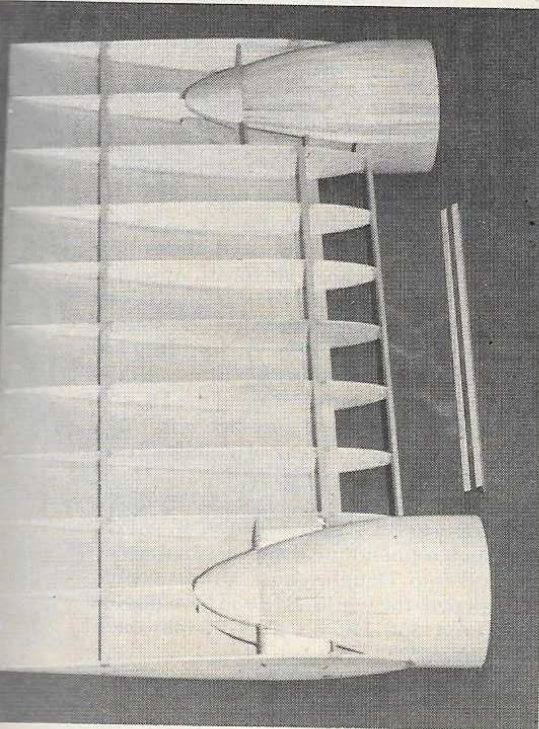






The main center-section mounts the two nacelles, beefed up to carry the load of engines and gear. **Right:** Smooth textured medium balsa forms skins. **Below:** The original center-section seemed frail, so hardwood beams were added as per the drawings. **Bottom:** Tony hanging on in a wind,

PHOTOGRAPHY: FRANK DELLAMURA



(Compare that to the DC-10 at 35 million a copy!).

By 1939 90% of all the world's passengers and cargo was being carried aboard the DC-3.

When World War II broke out the Allies ordered DC-3 transports by the thousands. These military models were primarily known as C-47's and many variations were variously known as Dakota's (England), C-48, 49, 50, 51, 52 (U.S.A.A.F.) and R4D's, C-117's (Navy). The DC-3 was so rugged and reliable that all the combatants used them including the Luftwaffe! The Germans had captured many of them in Europe and assigned them to their own transport squadrons. They were kept flying by obtaining spares from neutral countries. I would call that the greatest kind of backhanded compliment.

Many DC-3's are still flying today, even though the last one was built in 1941 (36 years ago). Ozark Airlines, until recently, was still flying a DST version in regular service. The design was so good that in the mid 60's serious consideration was given to restarting production since no replacement could be developed that would be as economical and reliable. The aircraft companies are still trying.

The colors selected for the model are pre-1940 Eastern Airlines, although other possibilities are virtually unlimited. The correct trim and colors were surprisingly, not easy to find. After a lot of searching the information was obtained from the Smithsonian Institution in Washington, D.C.

### Fuselage Assembly

The fuselage was started first. I consider it the most difficult part and I like to make sure it's done right before I go on. The fuselage starts with a box girder structure built up of 1/4" square balsa with large temporary gussets. The gussets keep the girder from twisting or warping until the formers are glued to it. Once the formers are glued on the gussets are removed since the structure becomes very stiff. All formers are made of 3/16" balsa sheet.

The whole fuselage is sheathed with 1/8" balsa with the exception of the nose and tail sections. The nose and tail are built up with 1/8" planking and balsa blocks. All of the blocking was hollowed out to prevent excess weight from creeping in.

The tail block should only be tacked on for sanding. It has to be removed in order to install the horizontal stabilizer. Also, the

side windows are not cut out at this time. They should be cut after the final sanding and just before the first coats of color.

### Wing Assembly

Since the wing is so large it was built in three sections. The two outer panels were built separate from the center section which carries the nacelles. The wings are sheet over spar/rib type construction and it is basically a very straight-forward building job with no tricky work involved.

Once the ribs and spars are mated 1/16" balsa sheet is glued over the structure starting at the trailing edge. The next section to be covered is the leading edge. Before the wing center skins are glued on, the aileron control linkage is installed. Nyrods are used without cranks. There is ample room to bend and anchor the Nyrods. Be sure to leave enough of the Nyrods hanging out of the inboard rib of the outer panels so they can be slipped through the center-section when the three wing sections are mated. Mating is done before any of the wing's center skins are glued on.

Once the sections are glued together the ailerons are cut right out of the wing outer panels.

The center-section is built just like the outer panels. Start skinning at the trailing edge and leave a 3" gap at the trailing edge underside. This is where the center-section flap will go. Cut-outs for the nacelles are not made until the nacelles are completed. This will insure a better fit between the wing and nacelle skins.

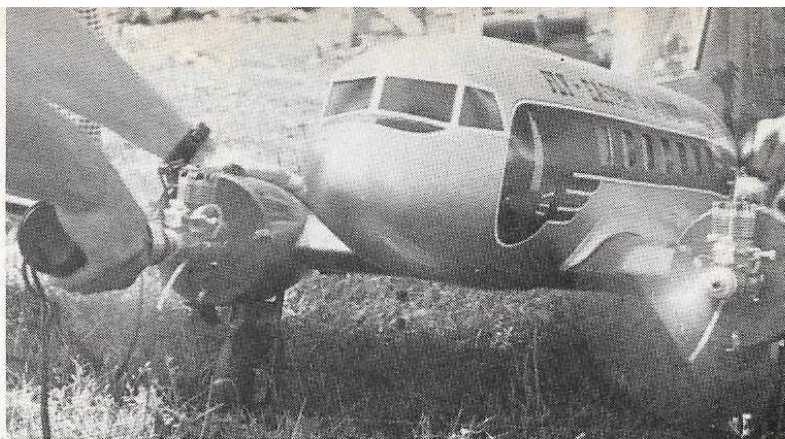
### Engine Nacelles

You should start the nacelles by building a balsa sheet box that will fit a Sullivan 12 oz. square fuel tank. Formers are glued around the box and the whole affair is planked over using 1/8" balsa strip. A 1/4" thick balsa ring is glued in place and the 1/8" plywood firwall follows. Rough sanding is next. The thick balsa ring allows you to round the nacelle front end to enhance airflow through the cowl.

The engine cowls can be built up in several ways. Balsa rings or fiberglass (using the die/ballon method) will do. A simpler way is to locate a pair of likely looking plastic flower pots such as the kind seen in hanging plant displays. A pair were found, in the local plant store which had the ideal shape. They were cut down and painted and made very effective looking cowlings.

Once the nacelles are completed they can





Electric starters are advised when you are dealing with a pair of engines. A field running session here to make sure the engines are well broken in. **Left:** Close up of the nacelle. Two good .45's are enough to haul it well.

be installed on the wing by cutting away the appropriate skin sections, on the center-section and epoxying them into place.

### The Tail Section

The horizontal and vertical surfaces are very straight forward. They are sheet over rib/spar construction. The sheeting should overlap the trailing edge slightly to create a hollow section to nest the movable surfaces.

### Landing Gear and Farings

The gear is built up of steel rod and installed directly into the nacelles. It is recommended that silver solder or welding be the method used since strength is the driving requirement. Welding was selected for maximum strength and the cleanest appearance. Bits of brass tubing were soldered on to the struts to make them look more realistic (see photo).

The wing farings, on the fuselage, were made from pieces of foam I had laying in the scrap heap. I do not know exactly what type it is (other than it is used for insulation and has a green color), but it is not effected by dope. After carving and sanding them to the correct shape they were glued to the fuselage and covered with Celastic.

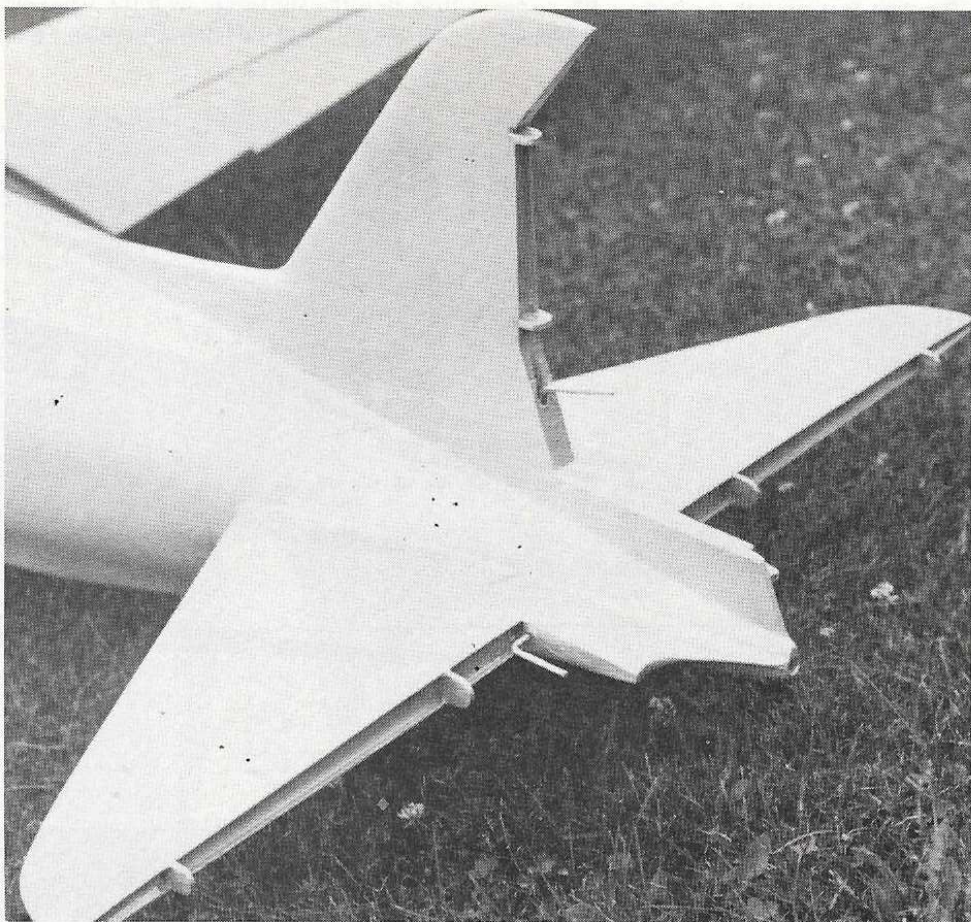
### Finishing Notes

Here is where you can make or break the model. Patience will be your most valuable ally. I intended that the model be painted with butyrate dope. The color scheme is silver, dark and light grey with light and dark blue, white and red trim. (This is described in greater detail later on.)

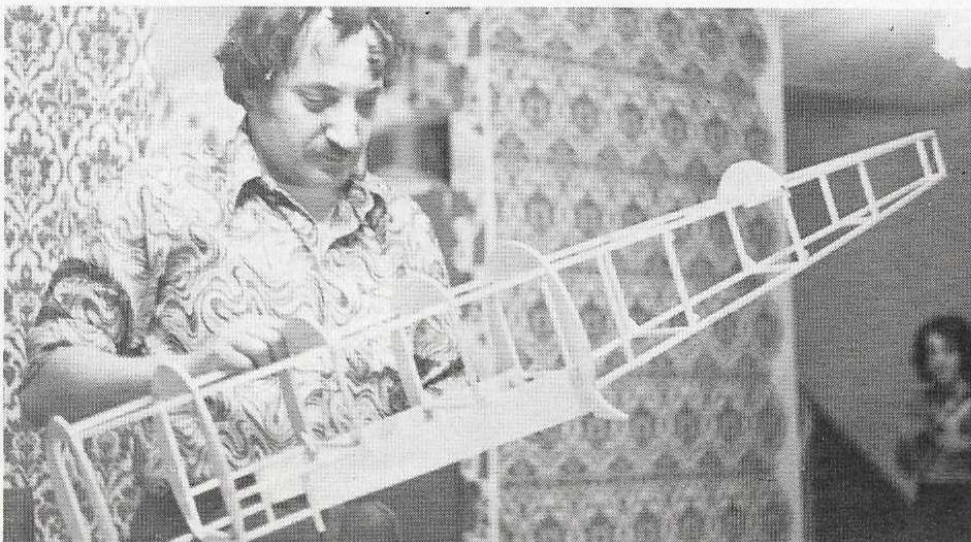
The first step is to assemble the model and sand all mating surfaces smooth. Each section is then sanded with #360-grade paper until moderately smooth to the touch. Two coats of clear dope are now sprayed on, followed by a heavy grade of Silkspar over the entire model. After two more coats of thinned dope the model is allowed to dry overnight, then sanded smooth using #360 paper.

The next step is optional. It adds weight but makes for a dead smooth finished surface. Start out by thinning some Pettit "Stuff" to a thin pea soup consistency. Apply the Stuff over the entire model and let it dry. After it is dry, start using #360 paper and finish off with #400 or better paper. The finished sanding job should have the feel of a formica table top.

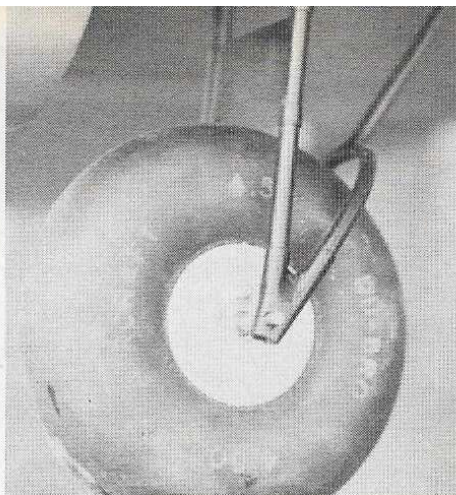
Next comes a spray-on coat of silver. The silver will show up the slightest imperfec-



The way the tail is made. Devoid of the movable surfaces in this shot, time to eyeball hinge points, filleting and general arrangement. Note the elevator cross-bar in position. **Beneath:** Tony may have used some leftover wallpaper for that shirt. The fuselage, in the framing stage. It's easily built.







Welded-up gear is reasonably simple, scale-like and adequate for the landing loads. Well braced. **Center:** Real or model? Low angle photo shots can make one wonder. It sounds realistic in flight. **Beneath:** The secret to the Douglas DC-3's fine performance is the lifting airfoil, ample area.

tion in the surface. Sand and rework all of the rough spots and bumps that show up. One more shot of clear dope and you're ready for the color application. At this point cut out all of the side windows. The colors go on as follows,

Silver: Fuselage, vertical and horizontal stabs, elevators

Light grey: Wing outer panels

Dark grey: Wing center-section and nacelles

Light blue: Rudder

Dark blue: Engine cowl trim, fuselage trim

Black: De-icing boots and landing gear

All of the trim was applied using Scotch-Cal. This is a decal material similar to MonoKote Trim Sheets but is much thicker and easier to handle. Scotch-Cal can be obtained from any large artist supply dealer. It is adhesive backed and no real problem to work with. The side blue trim is applied first. Run the stuff right over the windows. You can cut them out later. The eagle logo is

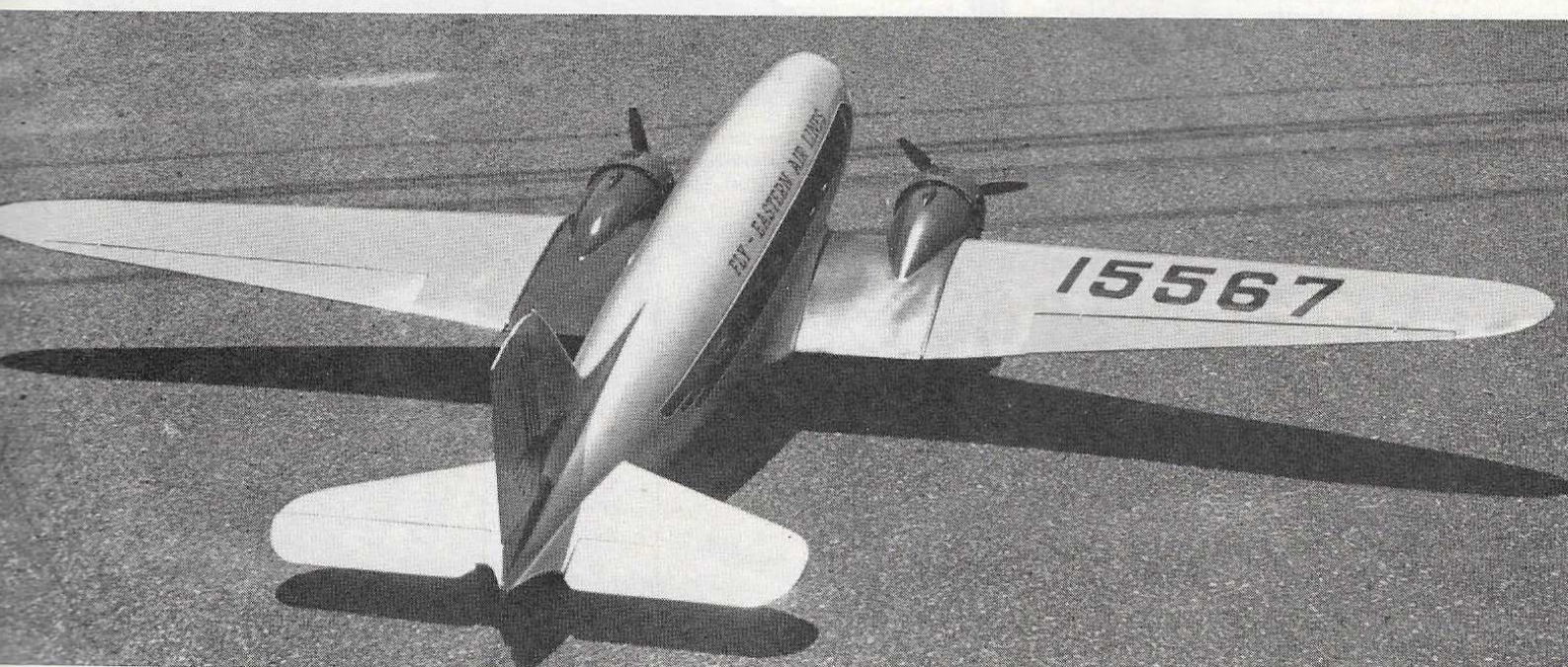
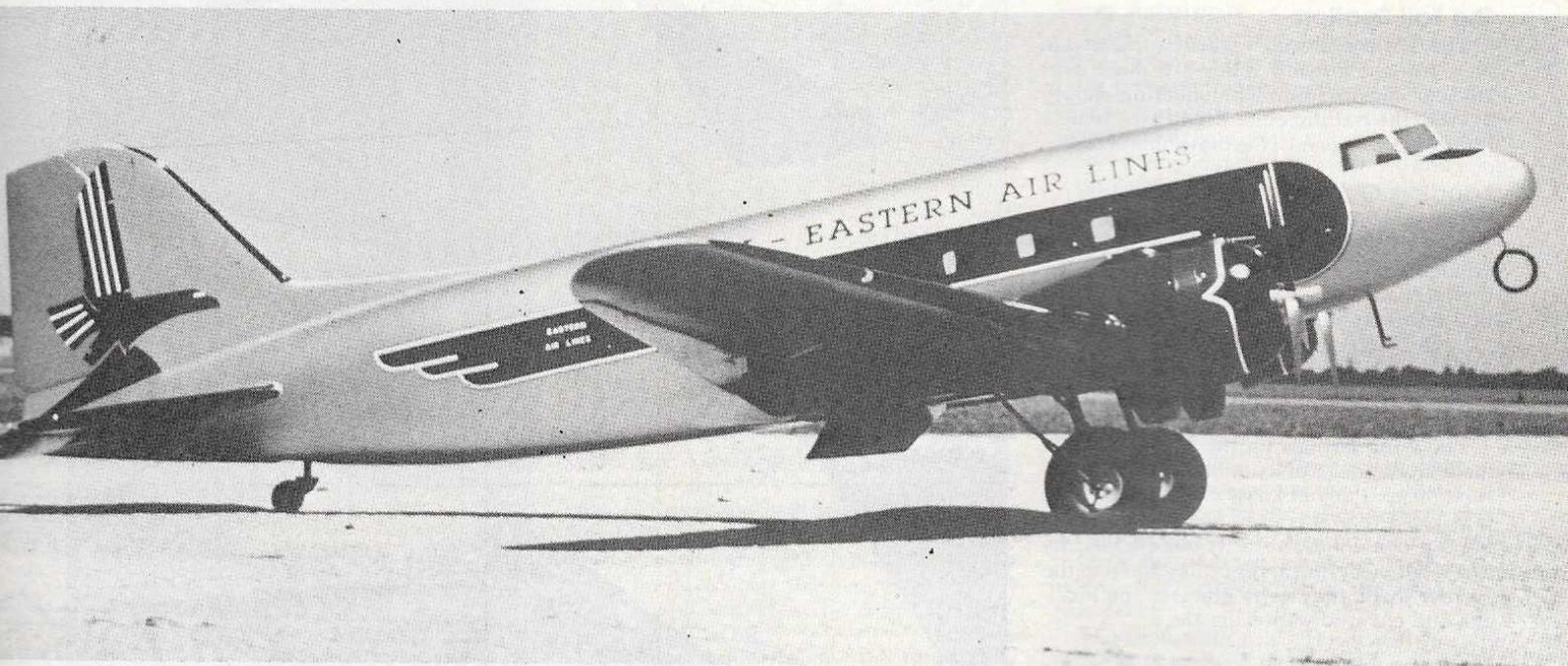
made up from red and applied right over the blue. I suggest four steady hands to do this job. All of the trimming is done in white tape.

The lettering used is rub-on (dry transfer) type and can be obtained from the same guy who sold you the Scotch-Cal. After all of the trim and lettering is finished, spray the entire model with RS Clear paint (two coats). These final clear coats bring up the shine beautifully.

All that remains is to make up the pitot tubes and DF loop out of some brass or aluminum tubing and your finish is completed. Don't forget the acetate windows.

### Radio Installation

A 5 channel Kraft Sport Series was used. The aileron, flap and throttle servos are mounted in the center wing section between the front and rear spars. The receiver and battery pack is mounted as far forward as possible in the fuselage. You will need an extension harness for at least one of the wing





mounted servos. The aircraft is tail heavy so do not be tempted to save a few bucks by moving the radio back. You are going to need all the weight you can get up in the nose. I shouldn't have to tell you that there is no space problem with this ship. The receiver antenna wire goes right through the fuselage top (just like the real ship) and is anchored to the vertical stab using a piece of extension wire insulated from the antenna.

### Flying Advice

Before attempting to fly, Frank and I did a good deal of ground running of the engines. This was done to be certain that the engines were synched and pulling equally over their operating range. Enya .45's were installed swinging three-bladed 10-4 props. Using no mufflers (the cowls provided a degree of muffling; and special dispensation was granted by the club for the first flight) the engines ran at a maximum of 11,500 rpm and delivered a static thrust of 6½ pounds. The ship weighed in at 13 pounds (dry) with 2 pounds of ballast in the nose to bring the C.G. into an acceptable range. The result was a wing loading of 29.7 oz. per sq. foot and a thrust to weight ratio of .5. That places a model of this size in the sport category as far as flying qualities.

As the day of first flight grew near, the jitters increased. Having put so much into this ship the thought of taking her up on this most unpredictable flight of all was too much! I decided to contact one of the best men in our neck of the woods, Nick Zirolì. Nick said he would be happy to act as the test pilot. Most of you know Nick through the fine kits and designs he has developed over the years. Nick has probably done more flying and designing of experimental R/C ships than most people in our hobby. He has a great feel for an aircraft and never has been known to panic. In other words "the ideal test pilot."

The first flight was held at the Islip Model Aviation Club field at Central Islip, New York. Their field had the best layout for the test flights (long grass runway) and they were kind enough to extend the invitation. Of course the grapevine had been buzzing with talk of the "giant DC-3" so by flight time quite a crowd had gathered.

Nick played with the engines until he was satisfied they would behave during take-off and flight. Next came a series of taxi runs. The wind was blowing at 10-15 mph and the ship behaved very nicely. She wanted to weathervane into the wind from almost any direction. That discovery was very encouraging.

The moment of truth finally came. Her tanks were topped off, engines restarted and taxied to the end of the runway. As he held the ship and wound up the engines (a final check) every eye on that field was glued on the big bird. Nick rolled open the throttles and the ship stood in her place until the thrust built up to the point where she began to roll along the grass strip.

Once it started moving the ship accelerated much faster than anticipated. After a ground run of 80 to 100 feet the DC-3 became airborne. Nick later said that he held neutral elevator and "let her fly off by herself". He had not reached full throttle when the ship started flying.

After letting it climb to about a 100 feet the throttles were brought back to a little over half position. With the left engine sagging a little and not being trimmed she had a ten-

dency to pull left. Right rudder and aileron trim was not enough so Nick had to hold right with the sticks. The condition was not severe enough to cause any real difficulty and could be corrected on the ground. In pitch the ship was dead stable and very civilized on the elevators. With the C.G. at 6" aft of the leading edge (measured on the center-line) and neutral elevator trim she put her nose dead level or pointed it wherever he wanted it to go.

One thing was established from the start. Two .45's are more than enough power. Estimated speed at half throttle was approximately 55-60 mph. That means that the potential max speed would be in the neighborhood of 75 mph. Two .40's would have been enough power to fly her. It's very possible that a good pair of 35's would do as well.

When Nick throttled back that dreaded event for multi-engined machines occurred. The left engine quit. Since she was already on landing approach (flaps up) Nick chopped the right engine to idle and came in.

Another pleasant discovery was made. He noticed no change in flying qualities with a dead engine. It has been said among flyers that if the engines of a DC-3 should stop the "old Gooney Bird" will "flap her wings to keep flying". Apparently the docile qualities of the real ship have been transferred to the model. Nick did not use flaps because they were not proportional. Although there is no apparent need for them, if they are used he suggested a proportional flap drive.

If you ever get the bug for a multi-engined ship and feel like taking on a big ship, the Douglas DC-3 is an ideal project. More and more twins are coming on the scene and from the way this one handles it might be a good one to tackle. It's not overly sensitive in roll or pitch and it will give you no grey hairs if an engine quits. You could go so far to say that it has the potential for being a twin trainer as well as being one of the prettiest flying machines you would ever want to own.



A flight shot here for your dreams. You have to hear those engines synching and see it against a cloud-decked sky to really appreciate it. **Below:** Tony can't hold it much longer, heavy in a wind.

