Mooney M-18

by Stan Hines

Photos: Bryce Petersen

An R/C Stand-Off Scale M-18 with a Fox Falcon .60, Goldberg retracts and World Engines Mk IV radio will make a great Spring project.

The *Mooney M-18* was an enclosed cockpit, single-place, fully cantilevered, low wing monoplane having flaps, fully retractable tri-gear and powered by a 25 hp converted Crosley auto engine. It had a 27 foot wing span, was 18 feet long, empty weight was 450 pounds, and it would cruise at 90 mph. The design was the predecessor of the *Mooney "Mite"* which was powered with both 65 and 85 hp Continental or Lycoming engines, constructed of a metal tube frame faired with wood formers and stringers skinned with plywood and fabric. The wings and tail surfaces were also basically wood covered with plywood and fabric. All control surfaces were plywood surfaced. Wherever possible the visible features of the model duplicates the type of construction used in the original plane.

The background of the designer, Albert W. Mooney, was covered in the previous article on the *Culver "V"* which he also designed, so I won't repeat it here.

For those of you who are interested in the designation *M-18*, the number is significant in that it was his 18th major design in more than 20 years of aviation engineering. While I have not been able to determine whether there are any *M-18's* or the later versions of the *"Mite"* still flying, there are a great number of four to six place *Mooney Model 20's* in active use today. All have the characteristic Mooney tail with its nearly vertical leading edge contrasted with the swept back leading edge of his many competitors.

The Model

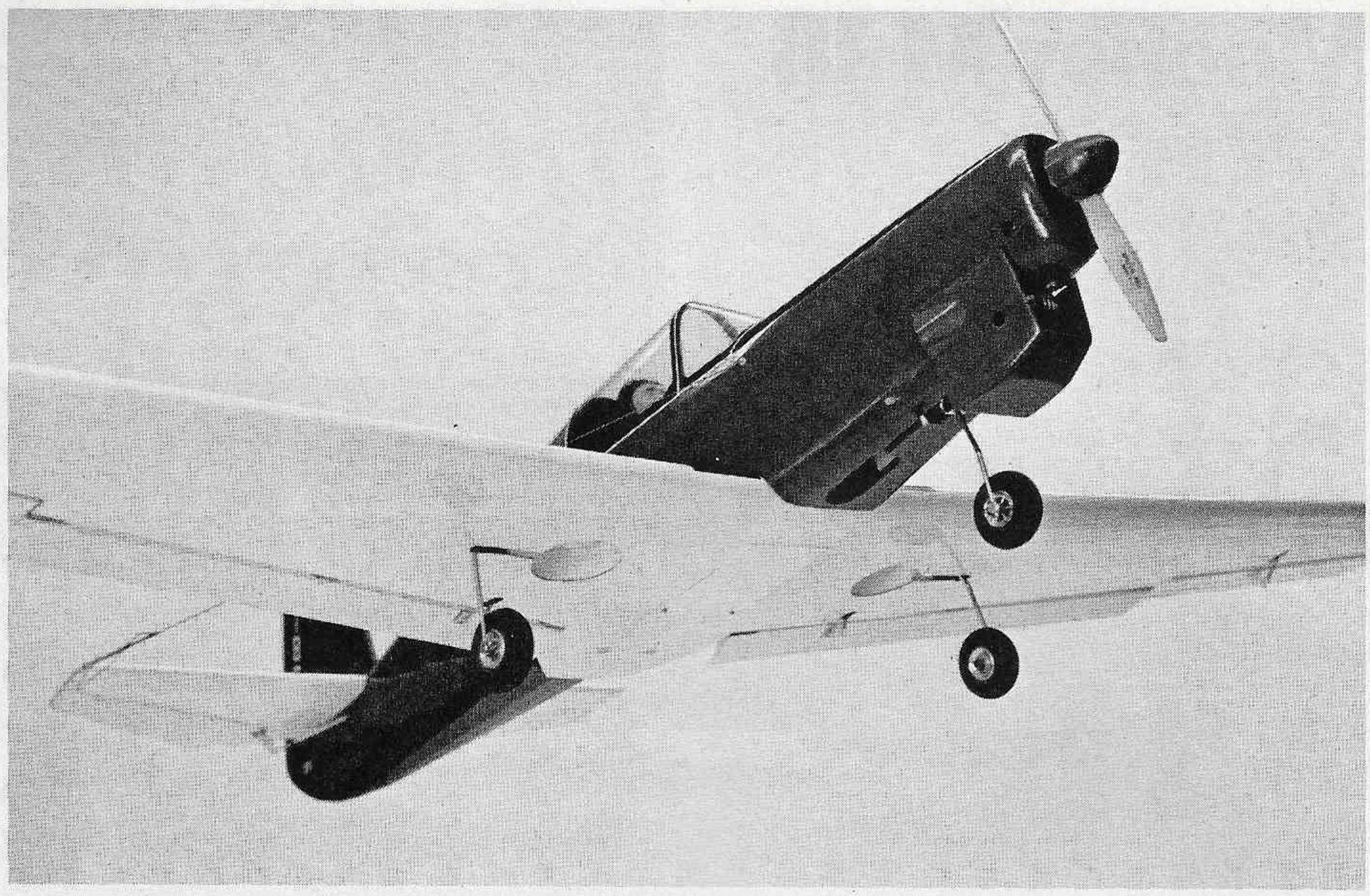
The plans for the model were drawn to a scale of 2.55 inches to the foot, taken from a three-view found in a November 1948 issue of a model airplane magazine of the time. The model has a wing span of 69 inches, a length of 45½ inches, and wing area 620 sq inches. It uses an NACA 23015 airfoil, weighs 6½ pounds and is powered by a Fox Falcon .60 engine. The original uses Goldberg tri-gear retracts, an 11-7 Top Flite prop, and is covered with red and white Super MonoKote. The radio installation is a new 1974 World Engine, Mark IV, 6 channel, assembled from a semi-kit.

I chose to model the original experimental plane powered with the automobile engine which accounts for the uneven spacing of the four exhaust stacks on the left side and the very much longer nose than is found on the later *"Mite"* models. The longer nose not only helps in the balance of the model, but also allows adequate room for the retract gear which is possible without any special attention other than to follow the instructions that come with the Goldberg retracts.

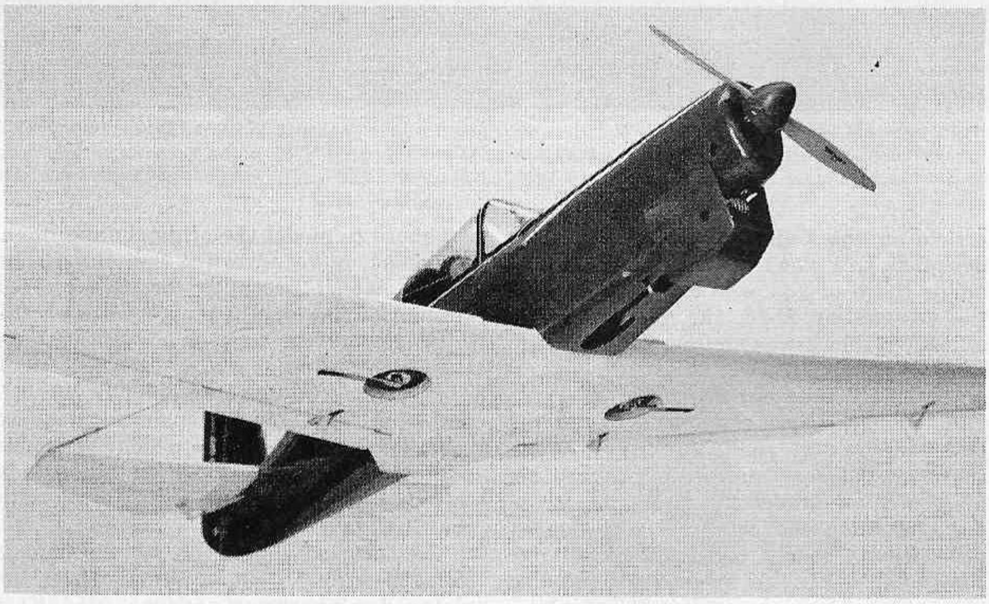
The forward section of the fuselage is sheeted with 3/32" balsa to simulate the plywood, while the aft section is MonoKote covered over the wood stringers. The tail surfaces have sheeted leading edges and sheet balsa control surfaces again simulating the plywood and fabric construction of the original.

The wings even more faithfully reproduce the original construction through the use of 1/64" plywood for the leading edge and for both flaps and ailerons.

Before getting too far into the how-to section, I'd like to have you look at the drawings which show the flaps in four operating positions. You will notice that the flaps are hinged at the bottom edge instead of at the top, and that there is a diagonal slot between the wing and flap that comes into play as the flaps are lowered. This



Goldberg retracts, for a clean machine. When you hit the switch after lift-off, and the wheels fold in, you know you're on your way. Good reliable units. **Right:** Stan aims his "Mooney" bird.



was done to achieve better flap effectiveness. The idea for this came from observing the relatively poor performance of model flaps, particularly on scale-model aircraft. It seemed to me that greater lift would be obtained from flap action if a greater differential pressure could be induced without excessive drag. As the speed of the wing drops and the angle of attack increases, separation of the smooth air flow over the top of the wing begins at the trailing edge. The resulting turbulence induces drag and reduces lift. If you will look at the drawing, you will find it showing the four flap positions together with their theoretical air flow patterns. At normal angles of attack and zero flap, we would expect laminar (smooth) flow on both sides of the airfoil. If the angle of attack and speed were such that separation occurred approximately at the leading edge of the flap, we might achieve two things by lowering the type of flap.

The second sketch shows the flaps at about 20 degrees where the leading edge would rise above the airfoil into smooth air and could reestablish laminar flow over its top surface. Secondly, by the ram effect due to the shape of the slot, air would be forced from above the wing to the underside of the flap. Theoretically at least, this should increase the pressure differential giving greater lift while reducing somewhat the turbulence, hence the drag. A conventional flap would increase the lift due to the pressure caused by the deflection of air flow under the flap only, whereas the turbulence above the flap and wing would be increased, increasing the drag and decreasing the lift. If these assumptions are correct, the bottom hinged flap employed on this model should be superior to a conventional flap arrangement. At larger flap angles, of course, a great amount of drag is created by either type flap.

At the time this article is being prepared, I have not had an opportunity to learn how to take the greatest advantage of these flaps due to the winter weather.

Here then are some construction notes that may be found helpful. The built-up fuselage and wing are not difficult, if a careful check is maintained to keep them straight. The first hint is to choose your materials carefully for uniformity of hardness. The second is to cut and notch everything carefully. The third is to stop if something doesn't seem to go together right and find out why. All the plans and templates have been carefully checked and redone during construction to give you "as-built" drawings. Although some materials of construction are shown on the drawing, I believe it would be helpful for you to read this section carefully. All formers excepting the firewall and one sub-nose former are 1/8" light Sig plywood. The latter two are 3/16" hard plywood. The inner walls of the section between the cockpit backrest

and firewall are also 1/8" light plywood. These should be cut to the plan shown by the large diagonal lines. The bottom edges of these two pieces are shaped to form part of the wing saddle. The rest of the wing saddle consists of 1/8" balsa sheet cut to the outline indicated by the narrow cross-hatched section on the plan. The final part of the wing saddle is formed by the 3/32" balsa skin referred to earlier.

You will find it necessary to notch the 1/8"x1/4" balsa stringers in the aft section of the plane along the diagonal line shown on the plan in order to make the sheeting and stringers flush at this point. The nose section is made of the 1/2" balsa block cemented in place and carved to shape after sheeting the fuselage. It should have the same cut-outs as are shown on the plywood former template.

The aft section of the fuselage employs 1/8"x1/2" crutch top and bottom as shown on the plan. This section is completed by adding the 1/8"x1/4" stringers inset 1/8" into the plywood formers.

The cockpit headrest is made of 1/8" balsa sheet cut to the dotted outline on the former. The forward cockpit former is made of 3/16" plywood, also cut in an arch as shown. The tail control surfaces are 3/16" balsa, stiffened as shown with round toothpicks. The forward wing mounts are two 1/4" dia. hard dowels set in the leading edge and the rear are 3/8"x20 nylon bolts which screw into a 3/8"x3/4" maple block set as shown between the wing saddles. The cockpit canopy is made of acetate sheet. You should make a template from stiff cardboard over the model. You may wish to add, as I did, a dummy pilot and an instrument panel at this point. A 1/16" cockpit floor can be mounted directly on the top of the 1/8" plywood liners. This gives a good protective box in which to place your radio gear and the fuel tank.

In the engine compartment I used maple motor mounts situated 1/4" above the centerline of the engine and spaced somewhat further apart than the engine mounting holes. To this is bolted a 1/4" plywood motor mount cut to suit the engine to be used. This allows me to use a wide variety of engines simply by making a new 1/4" motor mount. You will find the removable cowling makes easy access to the engine compartment for service or for exchanging engines.

A word or two about this cowling is in order. If you will look on the drawing you will see an internal baffle on the bottom which should come fairly close to the head of the engine you are using. This will force the cooling air up to an effective area. Also, the two air outlets on this cowling are functional (as they were on the original airplane) and should not be omitted if adequate cooling for your engine is to be obtained.

Usually I prefer to put modest power such as a .40 in my scale planes, but this time I chose a Sport .60. The Fox Falcon is a very reliable engine and I felt that the side-mounted plug might not foul quite as badly with this inverted installation. For better clearance of the throttle and better positioning of the engine, a 3/4" shaft extension was used on the engine. This gives a very compact installation with very little vibration and fewer skinned fingers.

Construction of the wing is a combination of a foam leading edge and rib construction as mentioned earlier to simulate the original construction features. The plywood covered flaps and ailerons are also authentic. The sequence of building I prefer is to make the leading edge first. Cut templates from the shaded areas on the plan and hot-wire two leading edges. To these epoxy the 3/16" square hard spars top and bottom. Measure and carefully cut a 1/64" plywood sheet large enough to cover the foam and extend back over these spars. Lay out a centerline on each sheet and epoxy the plywood to the leading edge of the foam first. When this has set, dampen the sheet well with a sponge or rag, then carefully bend and epoxy each side to the spar. I suggest starting your bend in the middle and working out toward either end, and doing the top and bottom halves in separate steps. This permits you to work on a flat surface and keep everything straight. These leading edges should now be checked for any twist or bulge before going on further. If you have worked carefully, there should be no difficulty. Next add the 1/8" ribs and rear spars. The two halves can now be joined with 3 3/8" dihedral under each tip. Use a piece of 3/16" plywood cut to the correct size and angle to fit between the center ribs and spars. This can be followed by installation of the retract system and the bellcranks for the ailerons and flaps. Please note on the drawing that these bellcranks are shown for clarity only as being on top of the plywood doubler, whereas in fact you will find that they will be underneath as seen in the photographs.

Stan hinged the flaps along the lower edge, feels it to be an advantage. Increased rate of sink helps over tree lines into marginal sized fields.

The crisp, lean lines of early Mooney designs earned them a spot in the hearts of modelers. Lean, clean, generous in wing, and enough tail also.

At this point you will find it advisable to sheet the center section of this wing with 1/64" plywood. To do this, I suggest you make a cardboard template for the top covering first, for the center section between the number three ribs. When this is completed, make another cardboard template for the bottom sheet which extends between ribs number six. Lay out the wheel wells and the center access hatch carefully so that the plywood may be cut to size before installation. By careful trial fittings I was able to make each of the top and bottom center section plywood covers of single sheets, thereby avoiding a center joint. Before epoxing the bottom sheet in place, don't forget the 1/8" plywood doubler under the wing bolts.

Very simple construction means light but strong components. Both the ailerons and flaps are built-up using a 1/8" spar and 1/8" ribs covered with 1/64" ply. Add blocks inside for the hinges and control horn mountings for additional strength. Build the ailerons and flaps on the bottom plywood sheet; in this way the hinges and control horn can be blind mounted before the top sheet of plywood is added. When that time comes, use liberal amounts of epoxy, especially along the trailing edge. Place the top sheet of plywood on a flat surface over a plastic film such as Glad Wrap and turn the whole bottom half of the assembly up-side-down on the top sheet. Hold it down tight until it becomes tacky and then place a straightedge such as a ruler or yardstick along the trailing edge and press down hard for a few minutes. There are no trailing edges except the two sheets of plywood epoxied together, but this gives a fine knife-edge that can be trimmed and sanded to final shape easily. Furthermore, these will not warp or nick easily regardless of the covering you apply.

A good sized aircraft, flies with a wide range of power. Consider a .60 to be more than enough. .40 is quite adequate, very realistic. The aircraft responds well and forgives your minor sins.

The ailerons are hinged conventionally, but if you wish to follow my example on the flaps, hinge them along the bottom edge. You will note that I have left the top plywood covering on the flaps extend about 1/16" ahead of the spar so that I get good closure of the gap when the flaps are up. The wing is completed by mounting the flaps and ailerons and by adding the wingtip blocks and carving them to shape.

Prior to covering, all control arrangements should be installed and checked to make certain there is no binding or looseness. The only unusual connection is the siamese control necessary for the elevator. This is made up by soldering three short threaded pieces of pushrod in metal tubing to form a "Y". Plastic pushrod stock of the Sullivan style are screwed on to this assembly to convert a single rod into a dual arrangement behind the last fuselage former. Connect these to separate control horns on each elevator with adjustable snap fasteners. No outside tube is needed on these short, rear sections. The model is covered in white and red Super MonoKote, but there is nothing about this design to prevent you from using a different method if you prefer. All of these structures are very strong and rigid and should not warp.

Although I am not a hot competition pilot, I look forward to giving some of our scale buffs fits at the flying site with this very fine, stable, well performing bird. It has all the features for those extra scale points except multi-engine. If you want to go one step further and add a sliding canopy, I believe you could have a nearly unbeatable model for either Stand-Off Scale or true Scale. With a .60, it will do the AMA pattern with ease and those flaps will let you drop her right in the circle every time.