MARTIN MARS
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CONSTRUCTION NOTES

For ease of transportation, the model may be built with the wing in three sections, and the fin and rudder removable. All parts are held together with wire clips and nylon snap links. They can also be kept in place with the small rare earth magnets now available. Assembly at the field does not requite any tools, and set up time is only a few minutes. Assemble the wing upside down so that the nylon clips under the wing, and aileron clevises are easily accessible. If using a typical seven seat mini van, it is best to leave the middle and rear seats upright (without headrests,) and slide a six foot long sheet of thin plywood in from the rear, resting on top of the seat backrests. The centre panel of the wing will sit across the centre passenger seat, with the outer wing panels on top of it. Because of the tip floats, put these panels on top of the wing “upside down.” The fuselage sits on the plywood sheet, leaving room for other models and equipment.

FUSELAGE

The fuselage is a simple box with bulkheads added to the top and bottom. Build the two sides of the fuselage first, and join together. Notice that the sides slope inwards slightly towards the top, the width of the fuselage at the top being less than at the bottom. The sides of the fuselage aft of bulkhead #10 are in two sections. The upper ones come together at the tail, while the lower ones come together at the point of the second step.

Add bulkheads and sheeting to the curved upper surface of the fuselage. The lower semi circular bulkheads from 11B to the tail should then be added to the bottom of the upper section of the fuselage. In the case of bulkheads 11b, 12b and 13b, only the semi circular part of the bulkhead should be fixed in place. The remaining part between the upper and lower sections of the fuselage will be added after these semi circular bulkheads are covered. Before proceeding to cover these, read through all of the instructions and get the complete picture in your mind. While the shape of the outer skin on the section of the hull from bulkhead 11b to 13b is the most challenging part of the fuselage construction, it is not as difficult as it might seem. My problem is not in doing it, but in explaining it in words that make it easy to follow. The sheeting can then be applied to the bottom semi circular bulkheads from #11b to the tail, but bear in mind that a “V” shaped wedge from bulkheads 11b to 13b will later be covered by the skin that is applied to the sides of the lower part of the secondary step. That sheeting will extend up to join the sheeting over the semi circular bulkheads. Some of this “V” shaped wedge that will later be covered over can thus be omitted to save weight. Or it can be removed later by cutting holes in it from inside the fuselage.

The sides of the fuselage are just sheeted from the bottom up to a point an inch or two above the water line. First do the sheeting for the forward section, going back as far as bulkhead 10b. To sheet the lower section from bulkhead 10b to the end of the second step, including the 1/8” balsa fillet attached to the keel just beyond 13b, use a single piece of 1/16” balsa 22” x 4”. It can be glued to the side (lower section) of the secondary step. The top curls out to meet the sheeting that was earlier applied to bulkheads 11b to 13b. It is much easier than it sounds, especially if this 4” wide piece of sheet is dampened before applying. Most modellers attempting a project like this have built a low wing scale model like a Spitfire that has a gusset where the trailing edge meets the fuselage. One way to think this section through, is to lay the fuselage on its side, and think of the 1/8” gusset at the end of the secondary step as being the gusset where the trailing edge of a Spitfire meets the fuselage. If this is still not clear, ask for pictures on line of similar construction with the Albatross flying boat built much later.

Add the remaining lower bulkheads to the hull section and cover as indicated. The triangular balsa strips added under the outer edge of the planing section of the hull make it a concave contour. These really help in reducing spray and getting the model on the step promptly. This model will take off easily with about 75% power. With reduced power, the take off run is longer and much more realistic.

Multi engine flying boats do not use water rudders, but control direction on the water with differential power from the engines. Without either of these methods of steering on the water, a model is difficult to control in any kind of wind. Some may wish to go with a water rudder at the point of the second step, but differential power to the electric motors is much more effective. With series parallel wiring of the motors as shown on the plan, it is very easy to hook up differential power. When full rudder is applied during taxiing, the end of the output arm on the rudder servo closes the contacts on a micro switch and drops a resistance across the inboard motors. This cuts down the speed of the inboard motors to a realistic idle, and the outboard ones speed up a little. The system will work without the resistors by just using wire direct, but this will work like a brake and stop the inboard motors completely. It would not look so realistic. With this differential power it is easy to taxi cross wind in considerably windy conditions. At low taxing speed, turns of small radius can be made in the water.

TAIL SECTIONS

Because of the dihedral of the stabiliser it is best to make the spar of the stab first. Glue the two sections together over the plan as shown. Then one half of the stab is built while the spar of the other half is propped up. Next raise the completed section, and build the remaining half. Because of the dihedral, independent pushrods must be used to the two elevators. The simplest way is to split the pushrod just aft of the elevator servo and run two flex pushrods.

The fin and rudder in the prototype are made to be removable. This makes it much easier for transportation, but if desired for simplicity, they could be built fixed to the fuselage.

WING CONSTRUCTION

The wing is built in three sections, and again, this is to ease transportation. The centre section extends to just beyond the outer motors and will fit comfortably across the back seat of a mini van. The basic airfoil is an Eppler 197, but the plug in outboard sections use a NASA leading edge cuff to reduce tip stall tendencies.

The full depth 1/8” sheet balsa spar is continuous throughout the wing The ribs are cut and butted to the front and rear surfaces of the spar. Construction is as follows.

MAIN WING SECTION

Cut the main spars from 1/8” sheet balsa and join together over the plan so that the dihedral angle is correct. At each end of this section of the main spar, build the box that will receive the plug in outer wing sections. At this point the spars for the outer wing sections should be made, and the hardwood tongues attached that plug into the box that was made on the main wing section. It is easier to make these fittings at this point than later in the construction. Now glue hardwood strips to the top and bottom edges of the wing spar as shown in the plan.

Cut all the ribs in two at the point where they join the spar. Assemble one half of the main wing section with the spar of the other half propped up, just as was done for the stab. Notice that the leading edge consists of two strips of 3/16” sheet balsa. Only the first (inner) strip should be applied at this time. Attach the trailing edge. Next assemble the other half of the wing. Sheeting is now applied to the lower surface of the wing from the leading edge to the main spar. At this point the wiring should be installed for the motors. It will be noted that the wing is still not torsionally strong, meaning that it can easily be twisted. After the sheeting is applied to the upper surface of the same area, the wing will be very rigid and difficult to twist. Hence it is very important when applying the sheeting to the upper surface, to weight that section of the wing down on a surface that is perfectly flat. The remaining strip of 3/16” sheet balsa that forms the leading edge is now glued to the one in place and contoured to shape. Finally, cap strips are added to the rear sections of the ribs, and sheeting to the centre section where indicated.

The outer wing panels are built in a similar manner, but noticing two things. When applying the sheeting to the upper surface of the panel, the trailing edge at the tip should be propped up ¼” to provide the correct washout. Then notice that the outer strip on the leading edge is ¼” thick instead of 3/16” to allow for the larger radius of the leading edge in the area of the NACA cuff. The tongue and box sections for the secondary spar need to be added to the outer wing panels as well as the main wing section.

The construction of the tip floats, nacelles and cowlings is fairly basic. The nose ring of the cowling starts like a doughnut, and can be of one piece of thick balsa, or laminations.

CONTROL THROWS

Control travel for the elevators is 1” up and down. For the rudder it is 2½” each way. The ailerons should travel 7/8” up, and no more than 3/8” down. Importance must be given to this amount of differential in the ailerons, and it will be achieved if the control arm on the aileron servo is made as shown. At the start of the take off run in a flying boat, one of the tip floats will be in the water. It is necessary to lift this float out of the water using ailerons, or the model will want to turn in the direction of this float that is dragging in the water. Poor aileron design aggravates this problem in many models because of the adverse yaw that is inherent at larger angles of attack, such as while getting on the step. Two things are done in the design of the Mars to overcome this problem. Frise ailerons are used, and a substantial amount of differential is used in the aileron linkage. At the start of the take off run, while holding up elevator to get on the step, advance the throttle just a small amount at first until the wings are levelled with both tip floats out of the water. When this is under control, advance the throttle further and relax on the up elevator as the model accelerates on the step. With practice this becomes one smooth continuous movement. A very slight amount of up elevator may be necessary at the point of lift off, especially if operating off glassy water.

In the prototype, Mabuchi 550 motors were used. These are the basic Speed 600 type can motors that have been around for years. They are not the best of motors, but were used in this model mainly because there were four surplus motors with Master Airscrew gearboxes on hand from the days of powered gliders. This model does not need a lot of power, and because of the series parallel wiring of the motors, each motor is running at the equivalent of nine cells on just 14 amps. At this higher voltage and lower amperage, these motors are reasonably efficient. For anyone buying new motors for this model, I would recommend getting the Kyosho Magnetic Mayhem 22 turn car motors. These are more efficient than the older can motors, and the same gear ratios and prop size can be used. When buying the Magnetic Mayhem motors, it is important to get the ones that have reverse timing if it they are to be used with the simple gear drives that reverse the direction of the output. With these motors, it would be reasonable to expect flights in excess of 10 minutes, using regular RC-1700 nicads. The model is usually flown on 18 cells, but will fly quite adequately on 16 cells. If the model comes our extremely heavy and needs more power, 20 cells could be used with the Magnetic Mayhem motors, but would not be recommended for the Mabuchi 550's.

In multi motor electric models, there is an increased risk of problems with radio interference from motor brush noise. It is always recommended to put a diode across the terminals of each motor in addition to the usual capacitors. The best diode to use is a Schotky, but a small 2N4001 is often sufficient on a lower powered model such as this. The radio and servos should be kept as far as possible from the motors and motor wiring, but this is taken care of with the layout shown in the plans. Servo leads must be kept short. Do not use outboard servos for the ailerons. These would require long leads running along the wing parallel to the motor wiring, and they would be very prone to picking up interference. At the low airspeed of this model, one standard servo is ample to operate the ailerons.

COVERING AND FINISHING
Most of the prototype is covered with red and white "TowerKote, but any low temperature film is suitable. It has been found over the years that film does not stand up to repeated use in water, so the hull and tip floats are best covered with light tissue (silkspan) applied with nitrate dope. This should be done before covering the upper part of the fuselage with film. The silkspan should be applied to the entire hull, and up to the top edge of the sheeting on the sides, this point being a few inches above the water line. Be sure to prime the hull and tip floats by applying two coats of clear nitrate dope before covering. When applying the tissue, first spray it lightly with water and rub it on to the surface while damp. Then brush a coat of dope on to the tissue. It will bleed through and cement itself to the primed surface below. After it has dried, apply at least one more coat of clear dope. The hull should be sanded after each coat of dope is applied, and when a smooth surface has been obtained, the colour should be applied. Krylon spray paint is known to be one of the lightest and most suitable for models of this type, but it is not available in too many colours. Automotive touch up lacquer in "Mars Red" as used on VW cars from 1982 - 1986 is a good match for red film coverings. When painting is completed, cover the remaining section of

the fuselage. Allow about an inch overlap where the film joins the top edge of sheeting on the lower part of the fuselage sides. It should not be continued to a point below the water line. .

EMERGENCY FLOTATION

With an electric powered model, because of the weight of the batteries and motors, there is not enough flotation to keep the plane on the surface of the water in the event of a crash, or the hull being punctured. Hence it is recommended that blocks of foam board be placed in the fuselage, or even some of the wing bays. The small air sacks used as packing are another option. When asked why the model of the Mars is so light, I point out the little air bags and say that they are filled with helium. In the case of several multi motor flying boats that I have flown for several years now, I have fortunately never had to put these flotation devices to the test. But in earlier years I lost a flying boat with a single pylon motor following a crash due to radio failure. When I got to the crash scene, all that was floating was the wing and tail section that had torn lose. The rest was at the bottom of the lake, and had it been a multi motor flying boat, the wing would have probably gone down as well because of the weight of the motors. Flotation is like insurance. You will only need it if you don't have it.

Enjoy building and flying your Mars. There is not much I can say about the flying. Most of those who have flown this one say, "It flies just like a trainer." I hope that yours does too.
Ivan Pettigrew

SUMMARY OF DETAILS

Martin Mars. April 2001 1/20 scale. Span 120 ins. Wing area 1,515 sq.ins. Airfoil, Eppler 197. with NACA leading edge cuff from outboard motors to tip. Length 72 ins. Weight with 18-1700 cells is 10 lb 5 ozs for wing loading of 15.7 oz/sq.ft. Flies adequately on 16 cells, but better endurance and climb rate with 18 cells. Mabuchi 550 (or Speed 600) can motors with 3.5:1 Master airscrew gearboxes driving four blade 10 x 7 airscrews at 5,400 RPM. Each airscrew made from two regular 10 x 7 Master Airscrew GF nylon props, notched at centre and crossed. Motors wired series/parallel with differetial power for water steering. Current draw 28 amps (14 amps each motor) giving static thrust of 84 ozs. For future builders I would recommend using 22 turn Magnetic Mayhem reverse motors. I just used old Mabuchi 550 motors in order to use up some that were already on hand. This model does not need much power. I have not done any tests to find the best gear ratio for Magnetic Mayhem motors. My guess is that 3:1 would draw about the same number of amps as at present, but give a significantly better climb, especially if using just 16 cells. Using the same 3.5:1 ratio as specified would likely give a better performance than at present, and also result in a longer flight time because of lower current draw. It is presently about 10 minutes. From experience, the Magnetic Mayhems are very efficient when used like this at about 14 amps.

Added note: Feb 2004. The leading edge cuff starts at the wing break where the outboard wing panels are joined. If the centre wing panel is left as built with the original #8 wing rib, there is an abrupt break in the leading edge at this point. To camouflage this break, the leading edge, in the few inches from the wing break to the outer engine nacelle, may be built up as shown in the drawing of wing rib #8.

For further details on flying boats, read the page about "Flying Boat Design' on the web page.

September 2005 update
As of mid 2005, the Kyosho Magnetic Mayhem motors are no longer available in most countries. Other racing car or buggy motors of 23 turns give an almost similar performance. The Peak Racing 23 turn Jaguar is a possibility. It has ball bearings and adjustable timing, so can be timed for reverse rotation. If motors of less winds are used, the gear ratio will have to be increased or the prop size decreased. Both of these changes have their disadvantages since gearboxes of higher ratios are more expensive and smaller props are less efficient.

In the Multi motor models that use the Magnetic Mayhem motors in parallel (such as the pair on each side of the Mars that are wired parallel), it has been found that the Jamara Pro 480 HS BB and Permax 7.2 volt Speed 480 motors can give the same performance as when using the Magnetic Mayhem motors.

The Mars would be considerably lighter with Speed 480 motors rather than the original Speed 600 motors. These Speed 480 motors are sometimes referred to as "long can speed 400" motors, and are not to be confused with the Graupner series of Speed 480 motors which have a different configuration and thicker shaft, apart from being quite a bit more expensive

Because the diameter of the motor can and the shaft thickness of the Jamara 480 and Permax 480 motors are the same as for Speed 400 motors, they use a Speed 400 gearbox. It is claimed by some that these Speed 480 motors can be run up to 170 watts input. In the applications given for the Sealand 480 and Albatross, the input is closer to 125 watts which is a conservative figure that results in better efficiency and longer motor life. The Permax motor has more turns than the Jamara, but of thinner wire. Hence if maximizing the performance, the Permax could be run at a higher voltage on more cells than the Jamara, but the Jamara with its winding of thicker wire can take more amps, and the voltage should not be too high. The efficiency of the Jamara motor may be a little higher than that of the Permax.

There is a large variance in propellers, but as a starting point it would be good to go with a 4.1:1 ratio MP-Jet gearbox on the Jamara motors with the original props, and a 3.5:1 or 3:1 ratio gearbox on the Permax 480. Tests should be done to see that the props are loading the motors for the desired amperage. For Jamara motors it could be 14 amps a motor which is 28 amps to the battery with series parallel wiring, and for the Permax the loading of each motor should be kept to 12 amps which is 24 amps to the battery. When using four Jamara motors wired series parallel, the recommended battery would be a 6S Li-Po. With the Permax motors wired series parallel it would be quite safe to run a 7S Li-Po, but at less amperage than the Jamara as mentioned above. The Jamara motors are available from John Swain of www.fanfare.f9.co.uk at Eight Pound each. He sends overseas orders by airmail at a reasonable cost, and can supply the MP-Jet gearboxes and 3mm "long shaft" prop adaptors that are necessary with these gearboxes.

With the price of brushless motors and controllers coming down all the time, it is getting more reasonable to think of using these in multi motor models, but remember that a separate controller should be used for each motor. Try to use the same size props as used in the model previously, and choose a motor/gearbox combination that will turn the props at about the same speed as when used with the brushed motors. Some of the cheaper brushless motors are not that much more efficient than brushed motors that are used with the right loading, so don't expect wonders. My personal feeling is that for the dollar spent, the biggest improvement in performance is achieved by first going with LiPo batteries.

On sheet #1 some broken lines show faintly underneath the lower surface of the second step. These should be disregarded. They show the original keel line at the rear of the hull, but take off performance was improved by raising the keel line at that part of the hull. The original lines were erased from the plan sufficiently for the older copy equipment that was used at the time the revision was made. But with improved technology in the new copy machines, the lines that were supposed to be erased now come through is some of the copies.