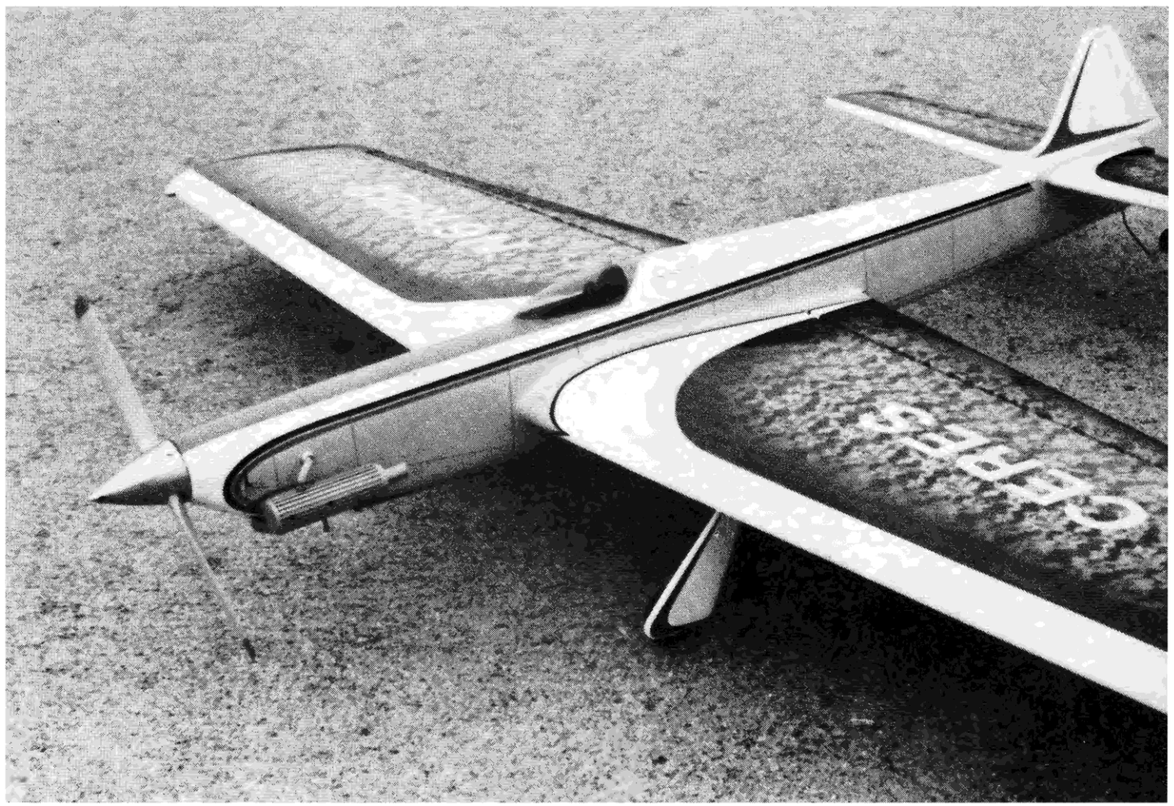






Bob McDonald assumes the "classic" pose of builder with plane **(above)**. In this case, the plane is Bob's own design Ceres. The stylish stunter features "I" beam wing construction and elegant lines **(left)**.

Ceres

By Bob McDonald

Unusual sheeted "I" beam construction is featured in this competitive ship.

If you regularly reed this wonderful modeling magazine, you will, undoubtedly, remember (I hope) my previous article in the April 1980 issue. You're probably asking yourself, "Why on earth would old Bob write another article about an airplane which looks so similar to his last one?" Well, Ceres does look a great deal like Aquila, with the exception of a different cowl and the addition of a turtle deck. In addition, the wing and tail plan views are, for the most part, the same, as are the nose and tail moments. There are, however, some very important differences about Ceres that make it a unique experience both to fly and build.

First, let me begin by explaining how Ceres came about. After the FAI trial in 1979, where all my "toy" airplane stuff was stolen, I had to start over. This meant I would need to build more than one new airplane, since I had no adequate spares. Well, to make a long story short, I decided to build an exact copy of the Aquila because I knew it would work well. After the new Aquila was under way, my Dad and I, decided to build two more, incorporating some new ideas we had been kicking around for the past few years. We decided not to change the size of the airplane, or the powerplant, because they had proven to be ideally suited to each other. Ceres is the most unique of my 1980 efforts.

The first, and most important, new thing about this airplane is the airfoil. After a quick glance at the plans, you should notice something a bit odd about the wing, that is, the flaps are an integral part of the airfoil. The idea behind this was to make the flaps more efficient. Higher efficiency in the flaps naturally means you don't have to move the controls as far to make the airplane turn. The advantage of using less movement is that you create less drag in the corners and, therefore, lose less velocity. Less air speed loss means the aircraft is going to pull out of the corners more quickly, making it easier to fly nice flat bottoms on your square maneuvers.

Because of superior efficiency in the turns, you can get away with longer control horns without damaging the sensitivity of the aircraft. I use horns of about 1¼" in length, which are nice because they give you an advantage in leverage, which makes it more difficult for the control surfaces to wash out. You may also notice greater ease in the control effort, which I like.

Ceres, aside from its aerodynamic marvels, also contains several neat construction features. Again I used my trick control system, which I will expand upon later because I feel it is a very important feature for this airplane, or any other you might build. Ceres also features a rather different way of mounting the motor, and last but not least, a *sheet covered* I-beam wing.

Sheet covered I-beams are not exactly a new idea. The first attempts at sheeting I-beams were made by Jack Sheeks, who's been at this longer than anyone living can remember. What Jack's reasons for trying this were I can't say, but they were probably much the same as mine. First, I thought, because the planked wing would require less dope than the paper covered wing, it would finish at about the same overall weight. This fortunately turns out to be true. Second, there would be a number of positive construction features. Like any I-beam, it would be quick to build. Further, it would be considerably stiffer and less prone to warping, although I haven't had much trouble with the conventional I-beam warping. Last, but certainly not least, it would be much easier to finish than the paper wing.

Now that I have pointed out the wonderful features of Ceres, you doubtlessly can't wait to begin construction. Before you start, there are two things you better have: a flat area of adequate size to build the wing on, and a scale to weigh your wood on. I use a gram scale for this because it is more sensitive than most kitchen ounce scales. My weight limit for acceptable wood is 5 lbs. per cubic foot or less. Figuring out what a given piece for balsa should weigh in grams is simple. Just take your trusty calculator in hand and multiply the volume of the piece in cubic inches by 1.31. If your piece of wood weighs more than the answer to this calculator, don't use it. Believe me, when you consider the amount of wood in a stunter, a gram too much here and there really adds up.

Once you have your stock together, and have somehow found a good surface to build on, it's time to get started. I will not detail the more basic areas of construction, because anyone attempting a project such as Ceres should have at least a stunter or two under his belt. This is not a simple airplane to build, but with a little care, it is not a difficult task.

Spar

I begin with the spar, which is not truly an I-beam. I no longer use caps on the spar because I found they are not necessary to the strength of the wing. This is particularly true for a sheeted wing.

The spar is built from two pieces of 3/16"×2" fairly hard balsa, spliced together with 1/16" bass wood doublers laminated to each side. Care should be taken to select straight pieces for this because more than a very slight curve can cause problems later on.

Once the lamination is complete, draw a center line on the spar and use this as a basis for the layout of the front view.

When the spar is cut to shape, cut out the center to clear the pushrod, and to accept the bellcrank and allow adequate swing.

When the spar is complete, the fuselage sides can be built. It is best to use 4" wide stock for the fuselage sides, because it is very important that the top edge of the fuslage sides be straight. Since the sides finish at about 2⅞" it sometimes is hard to get 3" stock to work. I would also suggest using 48" long stock, but if you can't get it, you can splice a little bit to the rear end as long as the joint is behind the elevator hingeline.

First, laminate the plywood doublers to the sides in the areas shown, then after straightening the top edge of both pieces, fasten them together back to back with a few

pieces of double face tape.

Lay out the spar, leading and trailing edge cutouts and the bottom edges. Make your cutouts carefully, particularly the one which accepts the main spar.

Separate the fuselage sides and cut the cowl lines to suit the engine and mufflere selected. Save the pieces removed to be used later as cowl sides.

The motor mount and bearers are now epoxied to the fuselage sides. Be very careful at this point to see that the bearers stay flush with the fuselage side top edge.

You will note the drawings show a 3/16" aluminum motor mount plate which is wood screwed and epoxied to maple bearers. The metal mount is stiffer than plain wood. This plate is also easier to make and lighter than the aluminum beams I used to use. The plate can be cut and carefully filed to the shape shown in the drawing. The bearers have been routed out behind the plate to form sort of a C-tube structure in which 1/4" holes are drilled as shown. Care should be taken in cutting the slot where the plate goes, because this must be at the proper depth.

Fuselage

You are now ready to build the fuselage. I begin by drawing the fuselage centerline and tacking square blocks down to jig the fuselage sides in place. It's also a good idea to have a wooden block cut to suit the width of the fuselage to be inserted at the front.

Slip the fuselage sides onto the main spar, install the spacer block, and set the assembly into the jib blocks. Check the centerline of the spar with a surface gauge to be sure it is level. You can now put in the spacer pieces which serve as bulkheads in the rear of the fuselage and install the firewall behind the fuel tank and tank floor. The main spar could be glued in now, but I prefer to take it out until I've carved the top and bottom blocks. When the sides are assembled the engine and mounting plate can be installed, which allows the nose ring and filler blocks foreward of the engine to be installed. The cowl side pieces can now be tacked in place and the filler blocks installed around the engine.

The top and bottom blocks are now tacked on. The fuselage is then carved to shape, and the blocks are cut off and construction of the wing can be started.

Slip the main spar back into the fuselage and put the assembly back into the jig blocks. Check the spar centerline height again and epoxy the spar in place. At this point the holes for the landing gear J-bolts should be drilled and the gear temporarily installed to see that the wings sit level and that the prop clearance is corrent. When you are satisfied that the attitude is right, remove the gear and begin wing construction.

Wing

Wing construction is started by cutting two rectangular tip plates from 1/8"×3" stock long enough to fit between the leading and trailing edges at the tips. Draw a line on these plates corresponding to the height of the spar centerline from the building surface and draw a vertical line showing the correct location of the spar at the tips.

Slip the leading and trailing edge pieces into the fuselage sides and glue them to the tip plates. Take great care at this point to see that the height of the centerlines of the leading and trailing edges corresponds with the spar centerline. Any misalignment at this point will result in a built in warp in the wing. It is also wise at this time to fasten several blocks to the board at intervals along the leading edge to keep it from bending when the ribs are installed. If you don't do this, it is easy to build a bow or S-curve into the top view of the leading edge.

Sometime prior to this point the ribs need to be cut out. Cutting the ribs is very simple, and doesn't take long. Cut several pieces of 1/16"×3" balsa to the length of the template and pin them together in stacks of ten or so. Pin the template to the stack of balsa, and cut around the rib shape with a jigsaw. Lightly block sand the cut surface, move the template down, aligning the edge with the pin holes and take another cut. Presto, ten ribs. Cut four ribs from 3/8" sheet to be used as the base ribs at the fuselage and we're ready to start.

Trim the inside edges of the wide ribs to get a good fit against the fuselage sides and glue them in. Next, start putting in the ribs at the intervals shown. As the ribs all start out being over-length, you simply cut the rear of each rib off with a razor saw to suit. When this is done, put in the shaped filler blocks between the ribs where the landing gear wires come out.

Now comes a tricky part. Get a good straight stick, pine or mahogony, about 1/4"×2"×36" or so, and glue fairly coarse sandpaper to it. Mark the top of all the ribs with colored chalk so you can tell where any high spots are, and while somebody holds the airplane still, use the sanding stick to remove any high spots and start the leading edge contour.

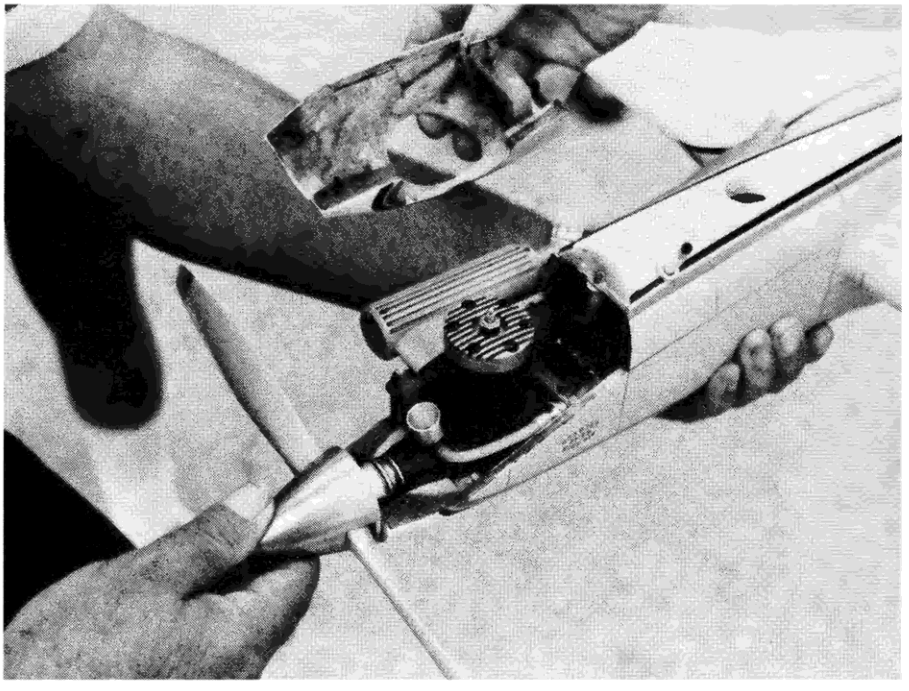
After you have done this, it is time to sheet the bottom of the wing. First you need to join the 1/16" balsa wing skins. Titebond glue seems to work best. Be sure you make nice clean joints. Sand the skins smooth before covering the wing, excessive sanding after the wing is covered can result in ripples and the like.

You must jig the leading and trailing edges to keep them from bending under the weight necessary to hold the sheeting in place. Now brush a watered down solution of titebond glue on the wing frame, put the skins in place and tack glue at the corners of the trailing edge with hot stuff.

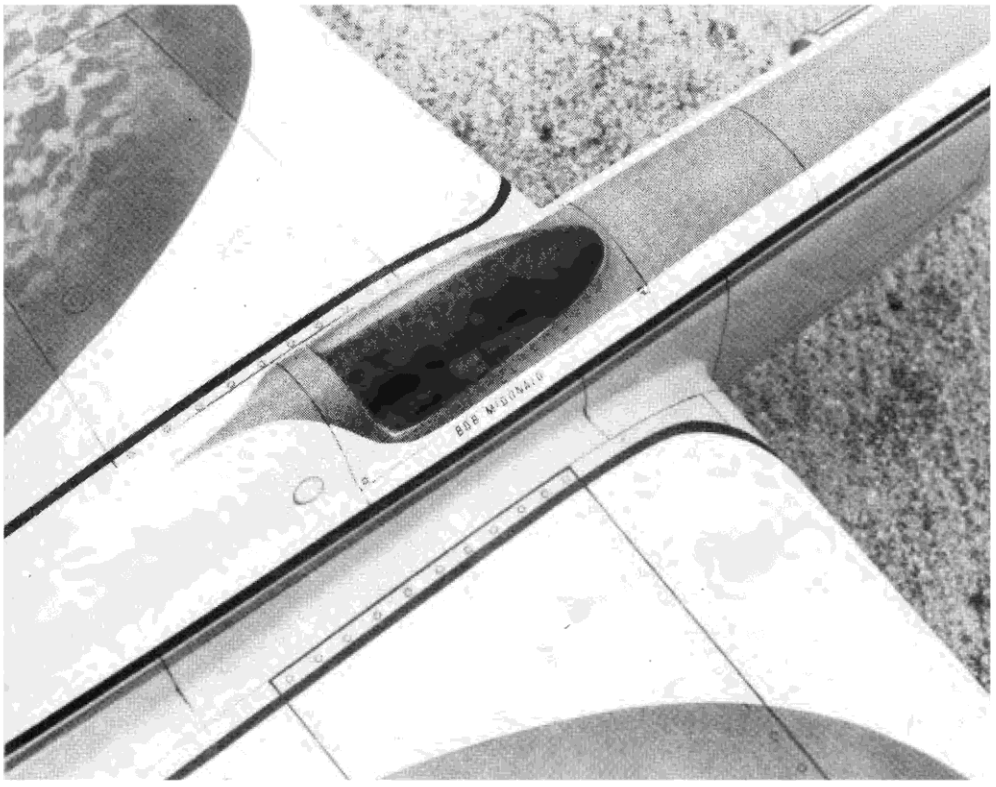
I have devised a good way of holding the wing skins down while they're drying. I sew brass rods into an old piece of bed sheet that drops over the wing pannels, but does not touch the working surface. This gives you fairly even pressure over the entire surface of the wing, and it seems to work well. You may need an extra weight here and there to keep the sheeting down.

After all this is dry, turn the airplane over and install the landing gear and bellcrank permanently. Don't forget to cut the slot for the leadout in the spar at this point. Now simply install ribs and sand as described before.

Prepare your upper wing skins as before and jig the airplane in the upright position. I use a large wood block attached to the bottom of the fuselage sides, just ahead of the spar, because this area is parallel to the top line of the fuselage. This block should be high enough to get the gear off the table. Then, as before, jig the leading and trailing edges to



Ceres with cowling removed. Engine is mounted inverted. This ship features some advanced construction techniques and should not be attempted by the rank beginner. All that work will pay off in the air.



The cockpit and wing fillets are nicely done on the author's Ceres. This is the area of the plane where neatness definitely counts. A slick job here helps the overall impression made by plane.

take the load of the sheeting.

Note: the wing may have sprung a bit from the previous sheeting application. This can be corrected by jigging so the centerlines of the leading and trailing edges check with one another. This may take some time, but it is important.

After the airplane is jigged sheet the wing in the same manner as before.

Flaps and tail surfaces

Next build your flaps and tail surfaces. These are shown as being carved from two sheets of 3/8" or 5/16" sheet, hollowed and laminated together. This works well if you can get enough acceptable wood, but I have also used a geodetic structure for the flaps and elevators, covered with 1/32" sheet, with good results.

Controls

Now it is time to install the controls, so I will describe the workings of my rather unique control system.

The elevators are driven by a pushrod which is connected directly to the bellcrank, and the flaps are connected to a sliding adjustable block held on the main pushrod with setscrews. You will note that each flap has a separate horn and pivoting "ear" from which runs a short pushrod that passes thru holes in the adjusting block and is secured with setscrews.

This adjustment system gives me two things. First, I have an accurate, easy way to "tweak" the flaps to level the wings. Second, I have found that if an airplane tends to turn a little differently up than down, I am able to correct this by trimming the neutral position of the flaps and elevators relative to each other. If you have some trouble with binding or springing when you first put this system together, just be patient and play with it a bit. Once you have the shape of the flap pushrods right, the system is as smooth as any I've used.

From this point on, construction is completely conventional. The normal caution involving getting the tail glued on straight is, as always, of great importance. After the tail is on, hollow the blocks and reattach them to the fuselage. Now, add fin and rudder, landing gear doors, tail and flap fillers, and you're ready to start finishing.

Finish

If you have a favorite method of finishing that yields both high quality and low weight, by all means use it. However, if you have been coming out a bit heavy on your finishes (I define too heavy as anything over 10 oz. from bare wood), you might try my methods.

Begin by brushing two coats of 50% thinned dope on the entire airplane. Now cover the whole thing with light grade silk. Next brush two coats of K&B superpoxy clear over the silk. Be careful to wipe each coat down with paper towels as it is being applied so no excess builds up. The silk and epoxy are much like fiberglass in strength, but are much lighter. Further, they provide an excellent base for the rest of the finish.

Once the epoxy is allowed to dry for a day or two, it should be lightly sanded with 360 or 400 grit wet or dry. At this point you can fix any seams you might have in the silk by simply sanding them flat.

Next add wing and tail fillets and blend in the rudder and turtle deck. You will probably find that because of the epoxy, it will be quite easy to blend these fillets compared to doing the same operation on bare wood.

Brush, or preferably, spray 3 or 4 coats of dope on the hole thing. Allow 6 to 8 hours curing time between each coat, the after completion, allow the dope to cure about a week before sanding with 40 wet or dry. During this curing period, I usually spray a little filler on the cockpit area, sand it, install any details I see fit, add the canopy and fillet, and then everything is ready for filler.

I use standard dope and talc filler, with a little silver to help show flaws. The filler should be sprayed in two fairly heavy coats, then allowed to cure again for about a week before carefully sanding with 400 then 600 wet or dry. After you fix all the little pits and flaws, spray a dust coat of silver to make the airplane a uniform color.

For color, I have used either dope or lacquer with equal success. Lacquers are nice because you never have trouble with it pulling up or bubbling the fillets, and it's quicker. However, if you're not careful, and pick a color that won't cover in one coat, it could prove to be heavier than dope. If you do use lacquer, you should only need one coat of each color and about 3 or 4 coats of clear top coat. Further you don't have to wait more than about two days for it to cure and you can rub it out.

Dope is probably a little lighter, but does take more time, and is likely to be more trouble. If you choose dope, allow about a weeks' curing time before rubbing and use about 6-7 top coats of clear with plenty of time between them.

Before closing, I would like to say a bit about the motor-tank combination I have found best for Ceres. I have used both the H.P. .40 and the S.T. .46 and have found the H.P. superior in my case. The H.P., being a .40, allows lighter lines and also provides as much or more power as the .46. Further, the H.P. seems to be quite durable, and not very finicky. I should point out however, I do not use stock H.P.'s, mine are modified by Art Adamisin, who lowers the port timing and performs several other changes, to make the engines more docile.

I have tried several tank and muffler combinations, on both the ST and the HP. For tanks, the best thing seems to be a uniflow tank running on muffler pressure. You can try making your own, but I suggest trying one of Mike Mustain's tanks. I've had good luck with them and he delivers quickly at a reasonable price. Mufflers had been a pain in the neck until recently, when I switched back to my old Adamisin muffler. Art's muffler seems to reduce power the least, and it certainly runs cooler than any other.

I'll end by reminding you that if you decide to build one of these planes, with care and attention to detail, you will doubtlessly find it a rewarding experience. Good luck, and I hope to see you at the Nationals with a Ceres, as long as you don't beat me with it!