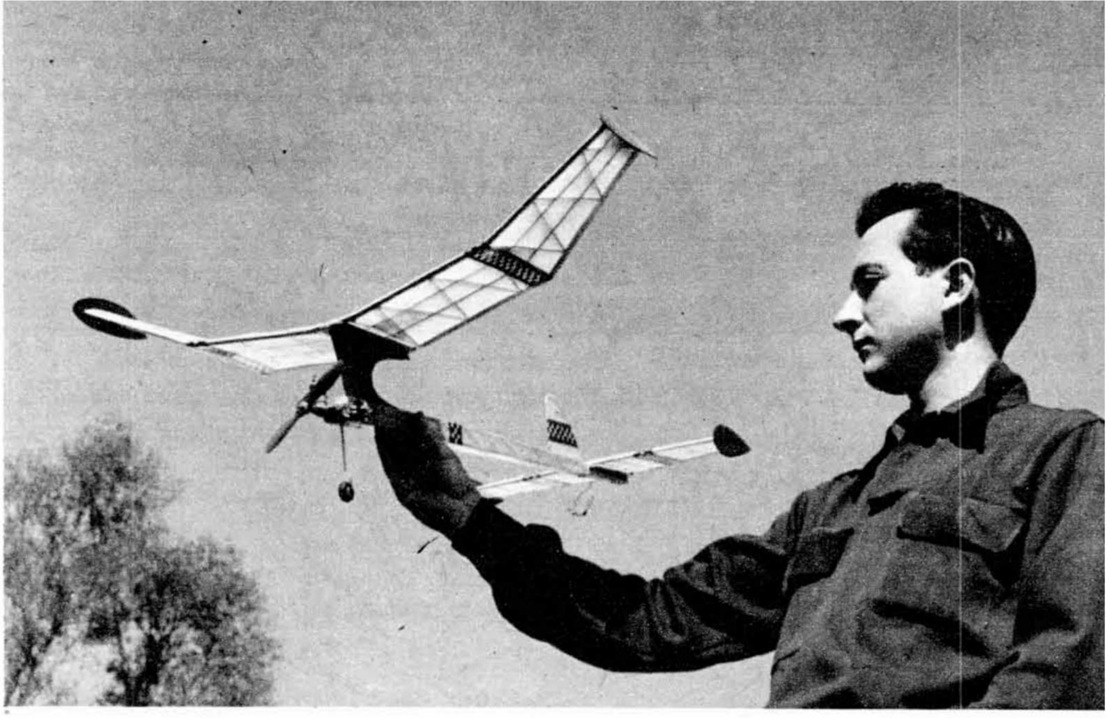


South of the Border Soarer: BATIRI

From down Mexico way comes this "engineered" Half-A free flight; original version won 1st at Tangerine Meet

By J. MANUEL TELLEZ

■ When I first seriously considered designing a F/F model that would stand a chance in a large U. S. contest, I came to the conclusion that it would need a skyrocket climb and a slow soaring glide. As we all know, these characteristics are based on contradictory design principles. Every model designer is torn between the two, trying to reach a satisfactory compromise. I began to wonder if there was a way of changing either principle from the usual standards without sacrificing one or the other. After some thought I believe I succeeded in changing both and in incorporating these changes in *Batiri*.

My first aim was to gain maximum altitude during the powered part of the flight. This depended on two factors, the flight path and the speed. The model would gain the most altitude by traveling along a completely vertical flight path at the greatest possible velocity. I first concentrated on obtaining the maximum possible vertical speed and soon realized that it depended mainly on a relationship between power and weight. This can be more clearly understood by studying several mathematical formulas involving power, and starting with the one which defines it: $P = \frac{W \times H}{T}$, where: W = weight in pounds; H = height in feet; T = time in minutes.

In other words, power is equal to foot-pounds per minute. Since one horsepower is equal to 33,000 foot-pounds per minute, we can get horsepower from the previous formula by dividing by 33,000. The formula then becomes: $HP = \frac{W \times H}{33{,}000\ T}$. Since vertical speed is equal to vertical distance or height divided by time, the formula becomes: $H = \frac{W \times S}{33{,}000}$ where: S = vertical speed in feet per minute. Solving the above formula for S, we find: $S = \frac{33{,}000\ HP}{W}$.

For simplicity's sake let us forget the existence of drag. Then from the previous formula we can clearly see that the rate of climb is only affected by the weight of the model, *irrespective of its size,* once the engine has been selected. Logically, we should always use the most powerful engine in a model of the absolute minimum weight that conforms to A.M.A. contest rules.

Getting back to the perfectly vertical flight path, I would first like to draw attention to an interesting fact. The model with the perfectly vertical flight path is not actually flying in the true aerodynamical sense of the word "flight" since the wings and other lifting surfaces are not contributing in any way to supporting the model. To the contrary, they even hinder the model during a vertical climb.

Therefore, these surfaces should be made and located in a manner to interfere as little as possible with the vertical flight of the airplane. To stress this point, I should say that if we could eliminate the wings entirely, the model would reach an even higher altitude. (Food for thought along the line of retracting or folding wings.)

After several experiments I found that the best way to obtain the vertical flight path was to permit the model to rotate about its longitudinal axis during the climb. It is important that the model does not have a tendency to turn while under power. Since the nose is pointed straight up, any turning tendency will make the model end up by diving into the ground. Any rolling (banking) tendency will not affect the vertical flight path. For this reason, it is important to try to eliminate any side thrust engine adjustments. The model should also nose up as fast as possible after the take-off. Should the model take too long to nose up, it would probably spiral into the ground due to the roll adjustment.

Briefly reviewing the desirable characteristics during the power run, we see that we should have: A) the lightest possible model. B) a vertical climbing model with a banking tendency but with no turning tendency.

The design principles behind the second part of the flight, almost entirely oppose these of the first. There is one exception on which they agree, minimum weight. We already have seen that the lighter the model, the greater the climb. In the second part of the flight, lightness limits the sinking rate, thereby increasing the duration.

The first controversy arose while determining the size of the model. The larger the lifting surfaces, the longer the flight. Yet exceptional size would slow down the vertical climb. I finally decided to sacrifice some speed during the ascent and build the largest possible model which would still conform to minimum A.M.A. weight specifications.

For example, in order to build a "B" ship for a .29 engine, I experimented until I found the largest model which would weigh no more than 29 ounces. The approximate results were as follows: For class AA (0.049)—175 to 200 sq. in. For class A (0.19)—600 to 700 sq. in. For class B-C (0.29-0.31)—900 sq. in. For class C (0.64)—Lord, behold!

The design of a model which, in spite of its size compared to its weight, is still strong, warp-proof, and flutter-proof requires a careful study of the airframe. All unnecessary material must be eliminated to keep the weight down. I studied every piece of the structure and cut out everything not considered essential.

The design soon reached another point of controversy. It is generally agreed that as far as glide is concerned, the higher the aspect ratio, the better the wing efficiency. Yet, a high aspect ratio introduces a serious structural problem for which I, frankly, found no satisfactory solution. A second deficiency of a high aspect ratio is its tendency to stop roll. As I said before, the model requires roll to aid stability during its vertical climb.

After trying several wing layouts I finally compromised with a 5.33:1 aspect ratio. This wing I divided into four panels of the same length which when joined with dihedral approximate the arc of a circle. The two center panels are of a constant chord. The tip panels are tapered in a 3:1 ratio to avoid tip flutter. These tip panels are terminated with a set of "end plates" which I found very effective in increasing wing efficiency. As a matter of fact, the use of these tip plates gives this 5.33:1 AR wing approximately the same performance of a 7:1 AR wing.

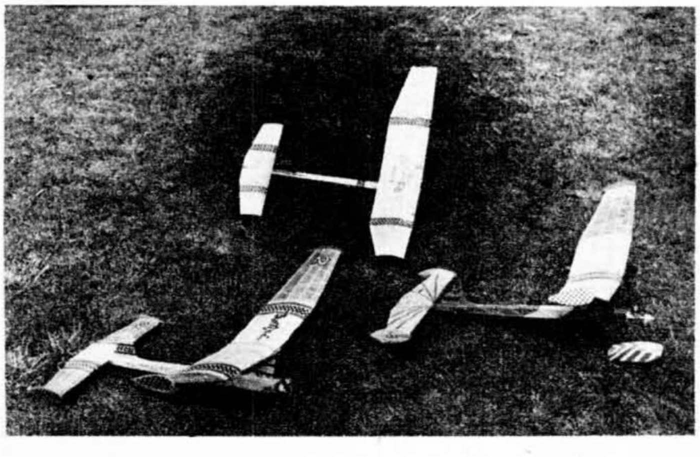
For an airfoil section I used an Eiffel 431 cut down to 85 per cent of its original thickness. I chose this section because I have often used it and am familiar with its behavior. On my next wing I shall try out an airfoil of the type Frank Ehling is using with a sharp leading edge and a flat bottom. I won't expect much improvement in lift (glide), but it might cut down drag at high speed and let the model climb even faster.

A certain amount of longitudinal dihedral (difference in angle of incidence between the wing and tail) is necessary to get enough longitudinal stability and to reduce the stalling tendency at the end of the climb. Unfortunately, the greater the longitudinal dihedral the greater will be the drag or opposition to climb during the powered flight.

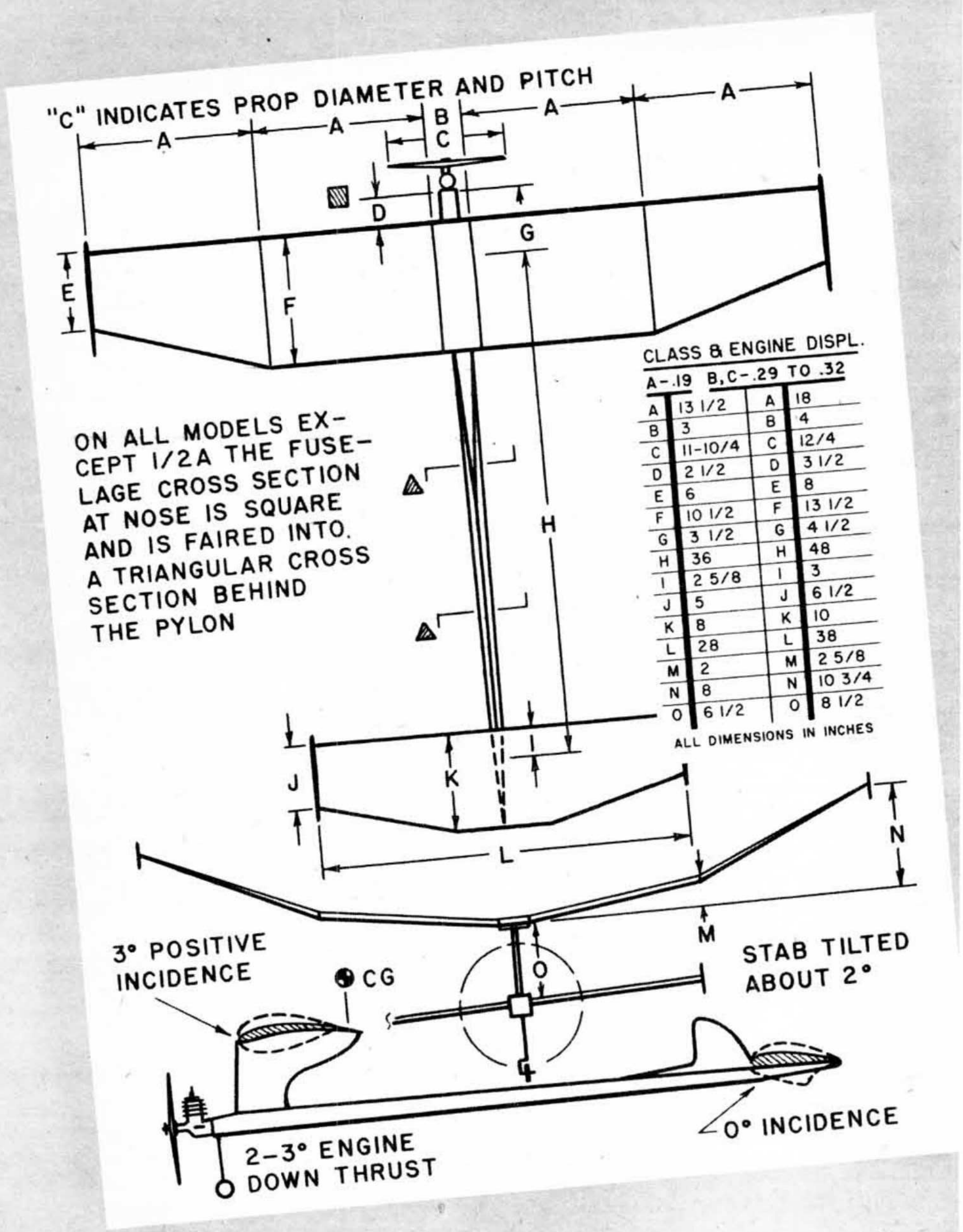
Therefore, I had to compromise at a point suitable to both powered and unpowered conditions. I found that the best arrangement was to set the stabilizer at zero degrees and the wing between two and three degrees. If while adjusting I found the model called for a setting outside of these limits, I would correct it by changing the position of the center of gravity.

To obtain the fast nosing-up tendency previously mentioned, a relatively high pylon is advisable. I adjusted the lateral area of the pylon experimentally until the turning tendency was corrected without resorting to side thrust adjustments. Regarding this, the effect of the pylon area is due to the prop wash striking this surface.

Some of the most colorful entries at the last Dallas Nationals were these flown by Tellez, one of the "model" representatives from Mexico pictured here at start of official flight during the American Nationals. Dimension chart for constructing larger versions of the Batiri is given on following page. "Batiri" means bebop. In appearance, dress and model design, author resembles US's Denny Davis.



Two other points should be kept in mind to get a stable vertical climb. They are the tail moment-arm and the stabilizer. We can better understand their effect by remembering the flight of an arrow. To be stable, an arrow has to have guiding vanes at its rear. Without vanes it would not be possible to keep it traveling along a steady course. In other words, the greatest part of the drag and guiding elements should be located at the rear. The farth



CLASS & ENGINE DISPL.

A–.19		B, C–.29 TO .32	
A	13 1/2	A	18
B	3	B	4
C	11-10/4	C	12/4
D	2 1/2	D	3 1/2
E	6	E	8
F	10 1/2	F	13 1/2
G	3 1/2	G	4 1/2
H	36	H	48
I	2 5/8	I	3
J	5	J	6 1/2
K	8	K	10
L	28	L	38
M	2	M	2 5/8
N	8	N	10 3/4
O	6 1/2	O	8 1/2

ALL DIMENSIONS IN INCHES

During vertical flight both the fin and the stabilizer act as guiding vanes. The farther back they are located the greater will be their stabilizing action. I would also venture to say that the stabilizer should be relatively thick to create enough drag to further assure vertical flight path stability.

After several cut and try experiences, I settled for a 35-40 per cent stabilizer with a full Clark "Y" or Goettingen 436 airfoil and a 60-70 per cent tail moment-arm. I also preferred a permanently fixed rudder with a neutral setting placed in front of the stabilizer.

In laying out *Batiri*, I tried to keep the overall drag down as much as possible. Since frontal area plays such an important part, I kept it at a minimum by designing the thinnest possible fuselage and pylon. I also gave careful consideration to the mounting of such gadgets as timers, the fuel tank, the dethermalizer and motor mounts. A cowled engine would have helped; yet, I preferred to lose its benefits for better engine accessibility.

As a last design recommendation, I want to mention mechanical stability. By this, I really mean the model's overall strength. Though light, simple, and easy to repair, it must not warp in hot or cold, damp or dry weather. It must not twist or flutter under strains imposed by flight. It must be a model where wing stab and engine settings can always be reproduced. It must be able to withstand the stress imposed by a dethermalized landing and have enough ground stability to allow safe R.O.G. take-offs.

The airframe must be logically designed. All possible stresses and the structures to withstand them must be studied. Wherever possible structural triangles should be formed. (A triangular structure element is statically indeformable.) Even the covering should be given careful consideration. No detail should be overlooked to produce maximum mechanical stability.

You will find the building of *Batiri* relatively simple and should not encounter any major problems. Nevertheless, I would like to make some suggestions which should make the construction even easier.

The most important factor is the proper selection of balsa wood. It should be very light with the exception of the wing spars and the four fuselage longerons which should be of medium-hard, straight-grain balsa.

The fuselage is of the usual rubber model type. With regard to this I have only one recommendation. Do not omit the diagonal braces. These are vital to the plane's strength.

The pylon is 1/8" thick and should be formed by two pieces of 1/16" sheet balsa glued cross-grain. The wing platform is made in the same way.

Bend the landing gear from 3/64" piano wire, sew with thread and glue to a small piece of 1/32" plywood. Cement this assembly to the front bottom part of the fuselage. Plank the top and bottom nose section. Then cut out a slot to slide the pylon into place. Make sure that the platform has the proper angle of incidence. Once the pylon is in place, complete the nose planking as indicated on the drawing. Cement the dowels for the wing, the stab and the engine supporting rubber bands into place. Notch wherever necessary.

The stabilizer and rudder are of straightforward construction. So is the wing except for the diagonal ribs. These cause no extra trouble once you get used to them.

The wing and tail should be covered before the "end plates" are glued on, but dope should not be applied until these plates have been fastened. This prevents the tip ribs from bending in as the covering tightens.

A very practical and durable motor mount can be formed as shown on the drawings. Cut a rectangle out of #24 or #26 gauge sheet aluminum, and notch out the four corners. Bend two flaps to fit over the top and bottom of the fuselage, and bend the other two in the opposite direction. Bolt the engine onto this mount. This entire assembly can be quickly fastened to the fuselage by wrapping rubber bands around the two vertical motor mount flaps and the dowel located behind the timer.

In addition to a better appearance a good finish reduces drag. It also adds life to the model allowing dust and oil to be wiped off easily before they can soak into the structure.

It is most advisable to plasticize the dope by adding a few drops of castor oil. This will prevent warping. When assembled, *Batiri* should balance approximately a half-inch in front of the wings' trailing edge. Adjusting the ship should not be difficult if you follow the procedure outlined. First test glide over grass until a straight flat glide is obtained.

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Batiri

If it should stall, correct by reducing wing incidence. Should it dive or the glide be too fast or too steep, add incidence. Make sure you glue corrective wedges before further flying.

For your first powered flight run your engine with the needle valve as far open as possible to keep the engine speed low. Hand launch into the wind and observe the model's attitude. It should have a very shallow climb with almost no turn. When the engine cuts, observe the direction and size of the circle in which it glides. If the circle is quite tight, you are in trouble and had better check your wing and tail surfaces for any signs of warping before proceeding. If the model glides straight or in a very open circle, you are ready for further testing.

Incorporate some roll (bank) by tilting the stabilizer. Approximately three degrees should be sufficient. Place a sliver of wood under the left side of the stabilizer for a left turn. Now try a second powered flight, leaning out your engine a couple of notches. If you have adjusted the model properly, it will glide in an approximate 40-foot diameter circle when the engine cuts.

Carefully observe whether this turn has not caused the glide to become steeper. If this has occurred, increase the wing incidence until the model is on the verge of stalling. If you now run the engine at full power, the model should climb vertically while executing barrel rolls. If it shows any tendency towards looping, correct this by increasing the down thrust of the engine. *Never* use side thrust.

Proper propeller selection is of the utmost importance in free flight models. This choice is even more important for a model climbing in a vertical attitude. Most free flight modelers tend to underestimate the propeller's significance. F/F fans should not be satisfied with the first prop that gives them a reasonably good flight.

Each particular engine requires a propeller of its own. For example, with a hot Wasp engine a seven inch diameter with a three to four pitch should do. On my particular models I obtained the best results with a 7/3 Tornado and fairly good results with 7/4 plastic props. A mathematical check will show that this pitch selection is correct to obtain a 600 foot climb on a 20 second engine run while operating at 10,000 rpm with approximately 60 per cent efficiency.

For the sake of the curious reader interested in the name of this model: "Mambo" is the name of a Latin rhythm comparable to American hot jazz. I originally designed a relatively hot plane and chose to call it "El Mambo" (this model took first place Half-A open at the Tangerine Internationals). Not long ago from "Mambo" evolved a Latin expression of bebop. It was a definite outgrowth of the original rhythm. So was my new model a definite successor to "El Mambo," and I adopted the name of its musical counterpart, "Batiri."