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top CUBmaster

■ *Many R/C flyers think of "Rudder Only" as the beginner's category—a place to start—a simple category, where there is a minimum to adjust and the least to go wrong.*

There are many rudder-only flyers, however, who have found its challenge great enough to resist the lure of the other categories.

In rudder-only you do have the simplest equipment to install and adjust. However, it is within this limitation that maneuvers must be performed. To loop a multi ship you blip the up button. In rudder only, there isn't any. Here it takes a good design, well balanced, with top trim adjustments, and it must be flown just right.

In rudder-only, only the equipment is simple. The adjustments, the trim, and the aeronautics involved plus an ability on the button make this category the most rewarding.

My first Super Cub kit was won as a prize in the 1957 Vermont regional model meet. This airplane had just been released by the deBolt Model Engineering Co. Since that time I have completed six "Cubs" and started three other. The first two were from kits, the others were "home built" and modifications were introduced along the way. The last airplane is presented along with its modifications and the reasons for them.

Too much wood and glue and you come up with a heavy model. For a high performance rudder job you must have a light one. The basic consideration is the weight of the wood. Balsa can vary tremendously from piece to piece. One advantage the kit offers to the novice is a reasonable selection of wood. The expert builder picks his wood with the greatest of care. One advantage of building more than one of a certain type ship is that you have a good basis for weight comparison at different stages of construction.

I had built two Rebels and liked this type of construction very much. It is my opinion that it can not be beat in strength-to-weight engineering. The Rebel is an excellent airplane although a bit small for a 19 engine, which I felt was about as small as I wanted to go power-wise.

At the 1957 Nats I became very much impressed with exhaust valve throttle operation and decided on the Fox 19 R/C for the Super Cub. SC-1 was completed in 1957 but was not contest flown. (That year I flew my "Gramps" with aerial camera, both at the Nats and the New England meet.) SC-1 was flown at the N.E. Championships in Quonset Point, R.I., to first in rudder-only in 1958.

Few changes were made in SC-1 . . . it is pretty much as per the kit. The greatest change perhaps was the building of the tail similar to that of the Rebel—the fin is glued atop the fuselage and the stab is placed on the bottom. This does away with the problem of keying the fin into position, and makes trim adjustments of the stab easier, since they do not affect the rudder linkage. Also, the stab on the bottom of the fuselage tends to give greater separation between it and the wing.

It did become apparent that a larger rudder was needed for escapement operation. It was added plus some aerodynamic balance at the top. Also the landing gear block was modified by the addition of two hardwood strips on each side, eliminating the screws in the block and the holes in the gear. SC-1 was flown for some time with one side of the intake plugged. The dihedral was increased slightly over the plans.

SC-2 was completed in 1959; it won first in the 1959 N.E. Championships held at Orange, Mass. It was pretty much like SC-1 with the exception that a solid fin was used instead of the built-up section. In it I did use a Bonner servo switched by a Varicomp. This gave very smooth control, and in a contest being judged heavily for smoothness this system was superior. When you keyed left, for instance, the Varicomp would go through right, but so fast that the servo couldn't follow it, in effect the servo would move from center to left—without going through right—very nice! There were two reasons why I didn't stick to this system. First, the weight, both of the servo and its batteries. Second, the delay in the servo—with escapements when you key right or left, you get response almost instantly. With the servo there is the time lag that it takes the servo to move from its center position to right or left. The problem being that you should fly either one system or the other, as it was difficult or impossible to interchange between both and still fly them at peak efficiency. I decided to stick with escapement-only control.

At this point I knew that I liked the Super Cub very much, yet I was looking for tighter rolls and smaller loops. The problem was to go to a new design concept or to make modifications. There were so many things that I liked about the Super Cub it seemed a waste to throw away what I already had so the modification course was taken.

SC-3 would be the experimental ship. It would be as light as possible since there was no question that a lighter airplane gave higher performance. In fact with this airplane I would go all the way and cover with paper. Also I would use the lightest balsa possible even to the point of "punk" wood in places. In fact, I called this plane "The Punk" because of some of the wood in it.

(Saving weight with paper covering was proved a fallacy. I built two wings which weighed the same. After covering one with paper and one with silk, six coats of dope were applied. The silk wing then weighed 1/2 ounce less than the paper one! Medium Silkspan and light silk were used. The silk, is lighter to start with, soaks up more dope, but apparently never catches up to the Silkspan in weight.)

In order to achieve greater rudder response the tail moment was shortened 3". I felt the design could stand this without nose shortening out because my first planes seemed to come out slightly on the tail heavy side. It may not be generally realized that in rudder-only the CG needs to be nearer the front than with multi. Most plans show just one center of gravity, which generally is too far back for good rudder-only operation. One exception is Lou Andrews' Explorer where he shows two CG locations depending on the type of control you install. Also I did some experimenting with SC-1 and found that the effective rudder action could be increased by the reduction of the fin area, without sacrificing too much stability.

smaller fin area, slightly larger counterbalanced rudder area, the Super Cub side nose blocks were left off and it was covered with Silkspan. The results were pleasing—in a word HOT. Rolls were tighter, loops smaller, it got upstairs real fast. I was quite happy with this airplane with one exception, the wind penetration was poor. Sure, it could be set up zero-

Therefore SC-3 is shorter, lighter, has zero and you could fly straight ahead into the wind, but on the first turn you ended up on the deck. I know now that my real big problem was the big stab which was giving me superior performance—as long as there was no wind. But at that time I hadn't realized this and attacked the problem of wind penetration by looking for a better airfoil section. I tried several and ended up with a flat bottomed 23012 section.

I am still flying it today and believe it to be superior to the 40% flat bottomed R/C section which had been so popular. The thickest part of this section is about 33% from the leading edge and the leading edge bottom curves up slightly. For normal flying this section seems to be snappier in both rolling and looping maneuvers. On windy days the angular difference can be reduced to 1° or less for good penetration into the wind, without complete loss of maneuverability—even with the large stab area. For greater performance in the wind a stab with smaller area should be built. Note that for a smaller stab area a larger angular difference will be needed.

SC-3 was completed and tested early in 1960. Intended only to be an experiment it was rather fragile. Realizing that it would probably be good for only one mistake, and since I'm apt to make quite a few of them, it was decided to build another as much like SC-3 as possible but with perhaps slightly better balsa and with fabric covering. This was SC-4 finished in time for the 1960 contest season. It won first at the Yankee Championships. Then before the N.E. Championships it was flown away (a 3A5 failed in the xmitter) and it was not found for four months. Meanwhile SC-3 was pressed into service. It won the 1960 N. E. Championships and top place at the Flying Bison's meet at Buffalo, N. Y.

SC-4 received very little damage; it hung upside down in a tree during those four months which protected the equipment from the weather. The receiver was not used again. However, after careful examination the escapements seemed to be in excellent condition and were placed back into service. It was with this recovered airplane and equipment that I won the high point trophy at the NJRCC meet in 1961. It was also on this airplane that the swept-back fin was tested.

SC-5 came out pretty heavy and has not been flown very much. It did win first at the ARCS meet in Syracuse, N. Y. in 1961—the only contest it has flown in. This plane is pretty much like 3 and 4 with the exception that a breakout motor plate was used for the engine installation. While this has some advantages, I prefer the solid beam mount with the larger cheek blocks for less vibration.

SC-6 has a higher thrust line, encouraged basically by touch-and-go landings. Also with this plane I went to the large size deBolt gear, which seems to improve touch-and-go landings. There seems to be no ill effects with the higher thrust line. Loops are just as good. A smaller amount of right side thrust is needed which seems to bear out Grant's zero-thrust theory. This plane won the 1961 N. E. Championships and with some poor button punching managed a 5th at the Nats. A Fox 25 has been flown in this plane most of the time. A good 25 is hotter than the 19s generally, but a hot 19 can be better than an average 25. I had a Fox 35 in this plane for a couple of weeks this summer, it is hotter to handle but a poorer flyer in this size ship on escapements. Loops were larger, maneuvers generally poorer. It's too much so I don't recommend it—a 25 is plenty.

After nine attempts and six airborne jobs, I feel that I have a pretty good airplane here. It handles well and will do most of the things that you want it to. I'd recommend it to anyone who is looking for a hot contest ship; yet it is rugged enough to survive some bad mistakes. For the beginner plug one side of the intake and cut down on the rudder movement.

At this point let me put in a plug for my installation system. Everything comes apart easily and fast in this ship. Detach one plug and the receiver slides out. Another plug and the battery pack comes out. By unscrewing the toggle switch nut the entire wiring system comes out of the plane, with the exception of that left on the escapement board. The escapement board slides out, too, after unsoldering the cam follower. This makes for very fast changing of receivers, battery packs, even the entire wiring system.

Quite a bit of experimenting went along with the building of these airplanes. Reasons and results are listed for those who might be interested. Probably no two people could ever agree exactly on what is optimum design, for the whole matter seems to be one of compromises. Prof. Gene Larrabee of MIT has said that there are two basic types of airplanes: #1) those controlled by rudder action and #2) those controlled by aileron action. The design considerations for either are not the same. The following obviously pertains to rudder control.

Experiments with wing design . . . In a rudder controlled airplane the banking is basically a function of the dihedral —when right rudder is applied the airplane is made to skid through the air, causing the left wing to present more area and incidence to the slipstream. This forces the left wing to lift. The banking we see is a result of this action. The rolling action of a rudder plane is nothing more than the continuation of the banking procedure and is therefore a function of wing dihedral. Thus the dihedral of a rudder plane is a most important consideration. The more dihedral you have, the more stable the airplane will be in the upright position and for any given amount of rudder action the quicker and sharper will be the response. Also when the rudder is neutralized the quicker will be the recovery to normal attitude. It would almost seem the greater the dihedral the better—but this is not so.

On the other hand there are three important considerations for top performance. It is nice for a rudder ship to stay in a turn once it is started. This makes for smooth flying as you need control only when entering a maneuver or recovering from it. An airplane with a lot of dihedral has to be either "held in" or pulsed around because each time the rudder is neutralized the airplane starts to recover. Secondly, the more dihedral the less lift for any given wing area. Thirdly, more dihedral gives more stability while right side up, but when upside down it's murder. In other words you are apt to have trouble staying in, on top of your loops. With an aspect ratio of 5-1 I believe a total dihedral of 12° is about optimum. It will recover from a turn, but not too abruptly yet will roll well and is not a problem on top of a loop.

Some experimenting has been done with wing areas and aspect ratios. I guess Mr. deBolt has done some too as I find it difficult to beat the 5-1 ratio and 600 sq. inches area for this size plane. Here again it is a matter of compromise and here's the story. With a large aspect ratio the airplane glides very nicely and it stays in the grove very nicely on loops. On the other hand the rudder action becomes poor and the rolling action of the plane suffers. With a small aspect ratio, gliding is poor, rudder action is good and therefore rolling is good, but, it also makes for an airplane that is difficult or impossible to loop.

As stated earlier, I've done some experimental work on airfoils and I prefer the flat bottomed 23012. This is much like the Clark Y which is also a good performer. I found the slightly curved-up bottom of the leading edge and 33% section better than the flat bottomed 40% section. I built a 2415 wing and found wind penetration was no problem with it, but encountered very poor maneuverability—a few rolls, very large, but no loops. At an extremely windy contest where it was a matter of flying or not flying you might do okay with such a wing, but it's pretty much out of the question.

Stab experiments . . . For any given angular difference the greater the stab area the more "loopy" the aircraft will be. I find that for high performance in rudder it must be on the high side. I favor 28%. However, the higher the area the greater your problems in the wind. My friend, Norman Littlefield, built several modified Super Cubs similar to mine, made one stab which eliminated one complete panel from *each* side. With this stab and flat bottomed wing you can bore into any wind . . . of course, maneuverability suffers. Looping with this area is out of the question. I like the thick symmetrical stab section, it is relatively warp-free when building. According to Charles Grant, this section gives better stability between high and slow air speeds.

Fin and rudder experiments . . . Due to the twisting of the torque rod with escapements, you get a certain amount of "blow back"—for this reason the rudder area must be much greater than that for servo and push rod use. A larger rudder of course, takes more power to move. Due to the small amount of power available from escapements it becomes necessary to use aerodynamic balance, else you find, particularly at high speeds, the escapement won't cycle through.

A rather small fin seems to be in order for rudder-only operation. It lets the airplane enter and recover from maneuvers rapidly, also for a given rudder area and movement a smaller fin will give greater rudder action. Of course the fin must be large enough to provide stability during straight and level flight. Get it too small and it's like trying to balance your plane on the head of a pin.

The swept-back fin, most interesting, was tried to see how much up effect, if any, could be obtained from sweeping back the hinge line of the rudder. I thought this would be most useful just before touching down on touch-and-goes and landings. I gave up on this fin because of two reasons. One, with conventional torque rod set-up the more you sweep back the hinge line, the more effective movement you lose. This smaller amount of effective rudder was most apparent near stall speed just when you needed it the most. Secondly, you like to set up your landing approach so that the button doesn't need to be touched just before touching down. I still feel that this type of fin has some fascinating potential, however more experimental work needs to be done.

Construction . . . Is similar to the prototype Super Cub . . . in fact my design could be made up from the deBolt kit with the addition of longer motor mounts, firewall, cheek and windshield blocks. The wing would require new ribs and spruce spars. All of my Cubs have been built around the R/C box as supplied in the deBolt kit. However, I use the box only as an alignment jig in building and not after construction is complete. All joints are double-glued with Ambroid. Some may prefer to use hard glue on the motor mounts. I have always used Ambroid with no problems. Glue is important since R/C ships are relatively long-lived.

Construction is started by gluing 1/8 x 1/2 strips to F2 and F3. When dry, F2 and F3 are attached to the R/C box with pins. The side pieces are attached to this unit; when dry, the tail block, 3/16 and 1/4 square stringers, F4, F5, and R6 are added. When dry install hardwood landing gear mount block, 1/4 spruce keel and fill-in blocks. Fit motor mounts to firewall and bulkhead 2A, then glue in place. After dry, the 1/4 sheet battery box formers and braces are installed along with 3/8 x 1/4 and 7/8 x 1/4 reinforcements and gas tank. The top and bottom sheets are added before the windshield and nose blocks are installed. The receiver and escapement slides, fuselage end plate, F4 and F5 stiffeners and tail skid and fin are next. Holes are made and the dowels fitted; they are then removed until after the model is covered when they are glued permanently in place. I find this makes for a cleaner covering job around the dowels.

I install the escapement winding hooks after the fuselage is covered; some may wish to install the motor escapement hook before the body is covered as it is more accessible then.

The wing and stab construction are standard and will not be elaborated upon here. For the type flying and mistakes I make the ply dihedral braces are a must; also, I feel strongly about spruce spars. They add little weight, yet never break in normal crashes. The key to weight in a wing of this construction lies in the sheeting—pick heavy sheeting and you have a heavy wing, pick light sheeting and you have a light wing.

I strongly recommend that only balsa be used for the wing leading edge. Many flyers, who have broken their leading edge upon striking a hard object, have been inclined to use a larger leading edge, or one of hard wood. The beauty of this design is that the leading edge *does* break . . . however, hardly ever back through the sheeting. This type of break can be repaired quickly on the field. With a harder leading edge the shock is transmitted back through the wing and the break is apt to come at the trailing edge of the ribs, resulting in a repair that usually cannot be made on the field, and one that is apt to require rebuilding of the wing.

I install 1/8 strips at the front of the trailing edge sheeting. I have not found this necessary at the spar. However, 1/16 webbing here (with the grain vertical) could protect the wing during a "rib-splitting" crash.

The stab should be kept as light as possible. A good piece of material should be used in the leading edge. Medium to light balsa for the other parts. The 1/8 x 1/4 braces keep the leading edge from breaking should the stab jackknife during landing.

I use three grades of sandpaper for sanding before covering: #50, #120 and #400. The #50 is used whenever large amounts of wood need to be removed, such as around nose blocks. #120 is for final shaping; #400 for that smooth finish. Two or three coats of dope go over wood areas that will come in contact with the covering material. Sand in between each with #400 paper.

The fuselage of my SC-6 is covered with nylon and six coats of Testors dope, plus trim. The wing and stab are covered with silk and six coats of Aero-Gloss dope, plus trim. I use #400 paper after each coat except the first and last. Go over the surface very lightly, just enough to take off the rough stuff. #33 Scotch electrical tape is used for masking tape when applying the trim. Fine black lines are applied with India ink and a speedball pen. Go over the surface first with #400 paper to give it a tooth so that the ink will take. Go over the surface with a coat of clear dope after it is completely dry.

Preflight instructions . . . Not much can be determined by gliding an R/C model—however, rudder jobs usually are light enough so that you can tell if they are gliding straight or not. If it doesn't glide straight the rudder neutral position can be changed slightly after checking to make sure that the problem is not caused by a wing warp. If you do have a wing warp it can usually be steamed out as long as the frame work wasn't warped before covering.

Before letting her go be sure that the R/C gear is working 100% at a distance and with the engine running. Make sure the CG is in the right location and the engine side thrust is about okay. If you're new to R/C, plug one side of the engine intake and add a couple washers under the back of the engine (increasing the down thrust). Be sure to shim the stab or you will loop on take-off. With the full size stab, 3° angular difference between the stab and wing will be all you'll ever need for extreme maneuvers in a dead calm. Better shoot for 2° for the first flight. Keep the engine run short on the first one—20 to 30 seconds for an unplugged engine, less for a plugged one.

I'd recommend a hand launch for the first flight. Have your buddy give it a good straight launch, after checking the rudder action with the engine running. Keep corrective pulses short—just long enough to steer it around. There, now ain't that something! "How'd ya loop it?", ya say. Sonny, that's another whole book by itself! Besides we don't have enough fuel this trip!