deBolt's Interceptor Five is a swinger

Tremendous amount of research and testing behind this design which was top Easterner at Nats.

BY HAROLD deBOLT

Obviously the "Mark V" is a further development of the contest design which I have been using for the past 3 years. Like all good things the first never seems to be an all-inclusive answer. This one's great grand daddy was a mighty fine airplane with the performance of a thoroughbred; Mark V's Daddy won 2nd place at the Nats. I would be the first one to say that the Mark IV was not a perfect airplane, the original layout had a real glaring fault which showed up during the first flights and the fix which was used to get it to the Nats was no real cure for the problem. So, what has been done with the Mark V is to take the basic original design, use the improvements which have been proven along the way and cure the problem which occurred in the last one. The end result has to be a good one and the improvements which have been made along the way should be interesting to anyone who cherishes these competition designs.

To understand the "Mark V" completely it is necessary to go back and review the original design concepts since they are still the backbone of the airplane today. The idea was to design the ultimate by striving for the utmost in efficiency no matter what the effort and to try to obtain the best possible compromise for the engines and radios available. Fortunately for us, even though it may not be for the sport in general, the same basic engines and radios are still on top 3 years later. Today it still seems as though the .49 to .60 engines are "it" and that no great improvement has been found to replace the quadruple-proportional radio, at least for competition flying, so it would seem that the compromise still holds.

One of the cornerstones of the original design was drag reduction; it was felt that anything which tended to hold the model back could not help but detract from its efficiency. Therefore extreme effort was put forth to streamline and clean up the airplane. This resulted in a fully cowled engine, internal control horns, Camloc wing fasteners and on the first several versions the use of Retract-Gears. It was said that the only projection from the model's skin was the needle valve!

The second most important aspect of the design was the wing. It was felt that the most valuable portion of any airplane is its wing for this is the part that makes all the rest of an airplane workable. Hence, we went to the NACA and used all the very best data available in hopes that we could have the most efficient wing from

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all aspects possible. First this required a wing planform that would create the least drag while remaining extremely stable and developing ample lift under all conditions. The shape which evolved is the classic double taper with round tips which is still mighty hard to beat. The 65000 series of airfoils are of the laminar flow variety, extremely stable, develop ample lift, have one of the best lift-drag ratios and are symmetrical. This is a combination which is ideal for our competition stunt flying. We carried this even further and used progressive airfoils so as to take full advantage of the slight advantages found in the different versions of these. We used the 65018 in the center for maximum lift and progressed to the 65012 at the tips so that the tips would have more stability than the root of the wing. This meant that the wing would not have any "wing drop" tendencies no matter how slow you dragged in for a landing and yet the average foil of the wing would be 15% which is considered ideal by the NACA. The effort was even carried to the construction by using the "egg crate" variety which provides the least total weight while reducing tip weight to a minimum, both important for efficiency.

We carried the same sort of thinking used for the wing into the tail section where for the first time we used true airfoils with realistic lift-drag ratios, in fact we put the tail to work so to speak. To do this easily required the development of a new construction technique which worked so well that we are continuing to use it on even the simplest sort of models.

The item which contributes the most to making a model groove is the force arrangement and the concept used was to have the horizontal tail lift in proportion to the wing. Thus, as the model would change speeds things would stay in status-quo and no trim changes would be required. This involves the thrust line location and the lift developed by the tail through its size, airfoil, incidence setting and its moment arm. The original layout was quite good but also this is one area where definite improvement has been made as we will see later.

These then are the basics of the design—efficiency through the use of a really clean airframe, an efficient wing and a force arrangement that really works for you. What has happened since the original inception is a story which can show what development can do if given a chance. . . .

Mark I probably was the best constructed model of the series, it enjoyed a relatively long life and undoubtedly won more contests than all the others put together. Unfortunately, its one chance for real glory came at the California Nats where its pilot let it down rather badly. It did however serve well and showed us the possibilities of the design. One of the admirable qualities of the design which showed up in the course of its life was the ability to fly well in really stiff winds and make very decent scores. This was something new and very desirable when you consider that the performance did not deteriorate in the calm. However, it was when flying in the wind that the one weakness of the model showed up, this trouble did not harm the maneuverability nor did it detract from the slow speed performance or landing qualities. In fact it was only present while flying straight or level *into* a strong wind. What happened was that the model would fly real in direct proportion to

its speed and the velocity of the wind. In other words the faster the model flew and the stronger the wind the more the fish tail. With the passing of time we find that this is not an uncommon problem and that other designs have been known to have the same fault. I think it is safe to say that the problem was licked with the Mark III version and that our findings could possibly help with these other designs.

The Mark II version was worked out more by Dwight Hartman than myself. The object was to adapt the basic design to a fiberglass fuselage. Dwight did an admirable job in forming the fuselage and test flights proved that the little additional weight could be compensated for by the use of just a bit more power. In fact the use of a .51 in place of the .49 normally used did the trick rather well.

Mark III ended up by showing the first real improvement in performance and indicated that it had the greatest potential which we have seen. I feel that it was a far better machine than the Mark IV version used in 1965. We now hope of course that through use the Mark V will be just as good as III and perhaps have just that little bit more which makes it all worth while. Unfortunately I left Mark III in Dallas before it ever had a chance to prove itself in competition. I have often been asked what happened down there but frankly I can not say anymore today than I could then, the post-mortem gave up no clues. All I know is that I suddenly lost all radio contact and no positive reason was ever found for it. However, during its short life span of about 40 to 50 flights before the Nats it could be said that Mark III literally flew right off the work bench and gave us a good look at the design changes which had been built into it.

As I have said Mark I had a tendency to fish tail in the wind and this we hoped to eliminate in Mark III. I also said that I felt that we have cured the problem but this was only after the usual blood, sweat and tears. I believe just about one whole Winter was spent by Ken Person, myself, and Cornell Aeronautical Laboratory people researching the problem before the final highly problematical solution was found. A great deal of credit must be given to Ken and Cornell for their interest and their knowledge of the problem.

To get the facts straight it should first be said that a great deal of experimentation was done on Mark I to try to find a solution. It should also be said that this same problem occurred with Mark I versions flown on reeds by Person and on another using proportional flown by Jack Roth. At first it was felt that the problem was caused by lack of vertical fin area or by the relation of the amount of fin area to the dihedral of the wing. In fact, initial research indicated that this was probably the cause of the fish tailing, at least as far as the full scale people were concerned. As a result of this thinking both Ken and I did a lot of changing of the vertical area, we added it, subtracted it, placed it high and then tried low, but the fact remained that anything we did had absolutely no effect on the fish tail!

So, obviously that was not the cause of the problem, there had to be a culprit somewhere else. However, all this work did not go for naught as we found a distinct advantage from the use of a sub-fin. We found that the model would hold a straight course in some maneuvers much better when about 1/3 of the total fin area was located

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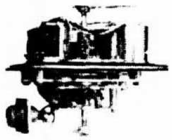


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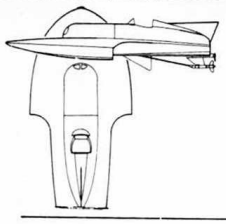
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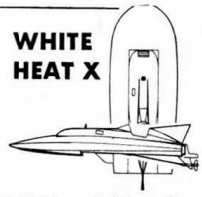
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below the thrust line. What it amounted to was that maneuvers such as the tail slide, wing over and the start of inside loops would track more easily when the sub-fin was on than when it was not. It would appear that this is a place for more research and possibly it could be an easy improvement to any of our models.

When the solution as we found it to the fish tail was first proposed it came from Cornell to Ken Person. Those people had decided that if this was not the solution the only other way of determining one would be to use a wind tunnel where very close observations could be made and as a result we were giving it serious consideration as we did not put much faith in the proposed solution. The idea as put forth was to change our thinking about the design rather drastically. It was suggested that what we had was no longer a model airplane in the general sense of the word but instead a miniature aircraft in the true sense of the word and one which possessed many of the problems inherent in the man-carrying machines. The main reason for the switch in thinking was the flying speed, it is one thing to have a model airplane floundering around in the air at speeds up to 50-mph and quite another to have one of same size zipping along over 100-mph! You can get away with a lot of things at 50-mph which just can not be tolerated at twice the speed. It's as simple as that, especially if you realize that we do have a scale effect. The shocker was when it was suggested that scale-effect-wise a model of 5½ foot span flying at over 100-mph could be compared easily to one seven times its size flying at 700-mph or close to the speed of sound and in the area of compressibility!

In any event and whether you go along with the suggestion or not it is a fact that full size machines have run into a fish tailing problem when they have approached the compressibility area which lies just below the speed of sound. Remember that our model only encountered this problem at maximum speeds and even then the air speed had to be added to by wind. The solution to the full scale problem has been to straighten the airflow out as it passes the tail. What happens is that the turbulent air leaves the fin in a sort of vacuum caused by the burbling of the air as it is going by. Therefore, in order to do its work it moves sideways until it strikes solid air which pushes it back towards where it came from and the inertia of the movement causes it to keep moving through the so called vacuum until it strikes solid air on the other side. The solid air on this side does the same job as the other had done sending the fin back again to come up against the solid air it had been affected by the first time. This results in sort of a pendulum effect or the fish tail as we have seen it. The full scale tests indicated that most of this rough air was caused by the intersection of the wing to the fuselage and/or the shape of the fuselage just forward of the tail. Most of these problems were cured by changing the wing intersection, adding wing fillets or changing the fuselage shape. In almost every case a solution was found with one or more of these changes.

The Mark III differed from Mark I only in the addition of wing and tail fillets and a slightly more rounded fuselage. I am happy to say that Mark III never did fish tail nor has it been noticed in Mark IV . . . whether the problem was caused by compressibility or not, the fillets sure seemed to do the job!

Mark IV was designed early in the Winter of 1964-65 but not built until 2 weeks before the Nats. It was a stop gap measure as I knife edged the Bipe which I had planned to use into the ground while showing off at a contest. With only a short time available the easiest way out seemed to be the Mark IV. So it was rushed to completion. In designing this version I planned on changing the appearance mostly for just the sake of the change. I long had admired the fuselage of the Caudron Racer and from the appearance point of view I felt that it would make an excellent outline for a Multi design. I guess you could say that the result was as attractive to look at as I had thought it would be, however, the aerodynamics of it left a lot to be desired. First test flights showed that it required a large amount of rudder deflection (trim) to make it fly straight and that such deflection detracted from the maneuverability of the model. For one thing it required a great deal of fiddling with thrust, aileron and rudder trim to get it to loop decently. But worse than that was the rolls . . . this design normally is most noted for the real clean on-a-string axial rolls it does with ease. This Caudron modification was just about the opposite—the rolls were beautiful barrel rolls and no amount of fiddling with the controls seemed able to make them string out. So, you can see that for Nats competition we sure had one beautiful flop plus the fact that it was only about one week before "N" day! On top of this we had attempted to use a "cavity" type fuel tank which seems to hold a lot of merit. Unfortunately, the material used to seal it proved to be soluble in fuel and we were having real headaches with fouled-up engines and trying to find a solution to the tank. We felt that the aerodynamics were secondary so all time was spent getting a brass tank into the model and making an engine run properly. Being a quicky we built this version minus the Retract Gear for the first time. This was a problem also, and we finally solved it by substituting a .61 for the .49 we had used before in order to obtain anywhere near the performance desired.

When we were finally able to get to the aerodynamics about all we could do was to remove the Caudron type cabin and give it a try. Even by doing this we did not get back to the original aft fuselage area location but it did help. We were able to remove most of the compensating trim and the model once more rolled properly and the loops could be flown through. Obviously the real answer was to go back to the original fuselage shape and use it without change. As you can see the Mark IV did very little to help the design along but we did learn one thing. Being a really stable design it had always been rather difficult to spin, they just did not want to drop off on one wing. So, with Mark IV we not only changed the vertical tail shape but we also extended the rudder to the bottom of

the fuselage. This change helped and we will use the idea from here on.

There was one thing about the Mark IV which made me real happy—we made a change in the force arrangement which worked out very neatly. Going along with the idea of making the tail work by lifting, we had explored airfoils and areas quite thoroughly until it appeared that we were getting about the most you could expect from these factors. However, there had been times when it felt like this idea was not working 100%. In other words, given just the right attitude or wind conditions, there would come a time when the model would not recover flat out as you might like. I had toyed with the idea of decreasing the wing incidence below that of the stabilizer on another model and the results had been good. With this knowledge we reduced the incidence of the wing to 1½° anl left the stabilizer 2°. The results were amazing. It removed all problems in getting up onto the step and the Mark IV would really groove out of any attitude you put it into—a gratifying change and nice improvement.

It would appear that the Mark V should be by far the best of the lot. With no fish tail even in the strongest of winds and an easier spin entry what weakness there might have been before has been eliminated. It will be a simpler airplane to maintain without the Retract-Gear, but it sure is a crime to have to give up the additional performance to gain simplicity!

Perhaps you would be interested in knowing some of the characteristics of the design in flight. First of all it is f-a-s-t! It really moves out and with a good running engine and a matched prop it will clock in the 80's real easy flat out. In spite of its speed it is quite docile to fly since it has no unusual or bad characteristics—it flies smoothly, easily and in the groove. It maneuvers very readily and requires very little control movement for all maneuvers (it is an airplane which flies through the maneuvers instead of being pulled through them). It may be trimmed to fly through loops without correction, but even if it starts to drift it responds instantly to any correction and will drop right back into the groove, if you let it. The rolls are fun to fly, full aileron and only the slightest touch of elevator will string them to infinity. Inverted flight requires no trim change—trim out flat upright and roll inverted. It will step right out hands off. It will take off flat and smooth by itself if you have enough runway. If not, nudge if off with elevator and neutralize—the climb out should still be flat and level. Landings are a bit different—the model is fast so it also glides fast. This means that you can not drop in to a short runway. You must fly in from a distance keeping altitude to a minimum. Fortunately you can slow it down nicely and touch down on the rear wheels. This is done by having your engine idle at below 3000-rpm where the prop will act as a brake (gliding speed is above the pulling power of the prop at this rpm) and gradually easing in up elevator. The approach will be nose high with no danger of dropping a wing and the speed will be much slower than otherwise. If there is one thing that this design is noted for, it's those pretty carrier-type landings! All in all, the Mark V should be capable of superior performance in any competition. Perhaps you would like to try it?

