THE INTERCEPTOR

Old Pappy always did finish his models beautifully, imagination and a good sprayer are responsible for this fine design and finish on his Interceptor.

By HAROLD deBOLT . . . THE ULTIMATE IS THE WAY PAPPY DESCRIBES HIS LATEST MULTI STUNTER AND IF THE NAME IS CORRECT, WE HAVE A MANEUVERABLE, HIGH SPEED POINT SCORER THAT CAN GO RIGHT OUT AND SHOOT DOWN THE BEST OF COMPETITION.

► My pet ambition for some years has been to take the time, throw caution to the winds, forget the commercial aspects and develop the best multi design as I know the laws of aerodynamics can produce. Anything which I have produced hereto has always been tempered by compromise in construction, assembly time and simplicity of maintenance. Also, not until the advent of the retractable landing gear, did we have all the requirements for super performance design. Now, however, we have the required equipment plus its reliability to make such a project feasible.

Before any actual paperwork was undertaken, a considerable amount of reviewing was needed to refresh our memory and also to have a look at the latest in aerodynamics. Special attention was given to airfoils to be certain that the wing, the most important part of any airplane, would be as efficient as possible.

I should like to give credit to two flying friends, Jack Roth and Ken Person, who have lent a very welcome hand with the initial tooling and labor and have made it possible for the first models to be built as precisely as possible. Between us, we have now flown seven Interceptors, all of which performed identically well, including Person's who used 10-channel reed equipment in his plane. Ken operated his Retract-Gear with extreme reliability by the use of the BA-1 switch plate in his Bonner engine servo. Performance of this design is something to behold, though it is not recommended for the tyro rcers.

You know, the Interceptor *(Continued on next page)*

Drag is held to an absolute minimum by cowling engine and use of Retract-Gear manufactured by deBolt, reduced frontal drag increases performance.

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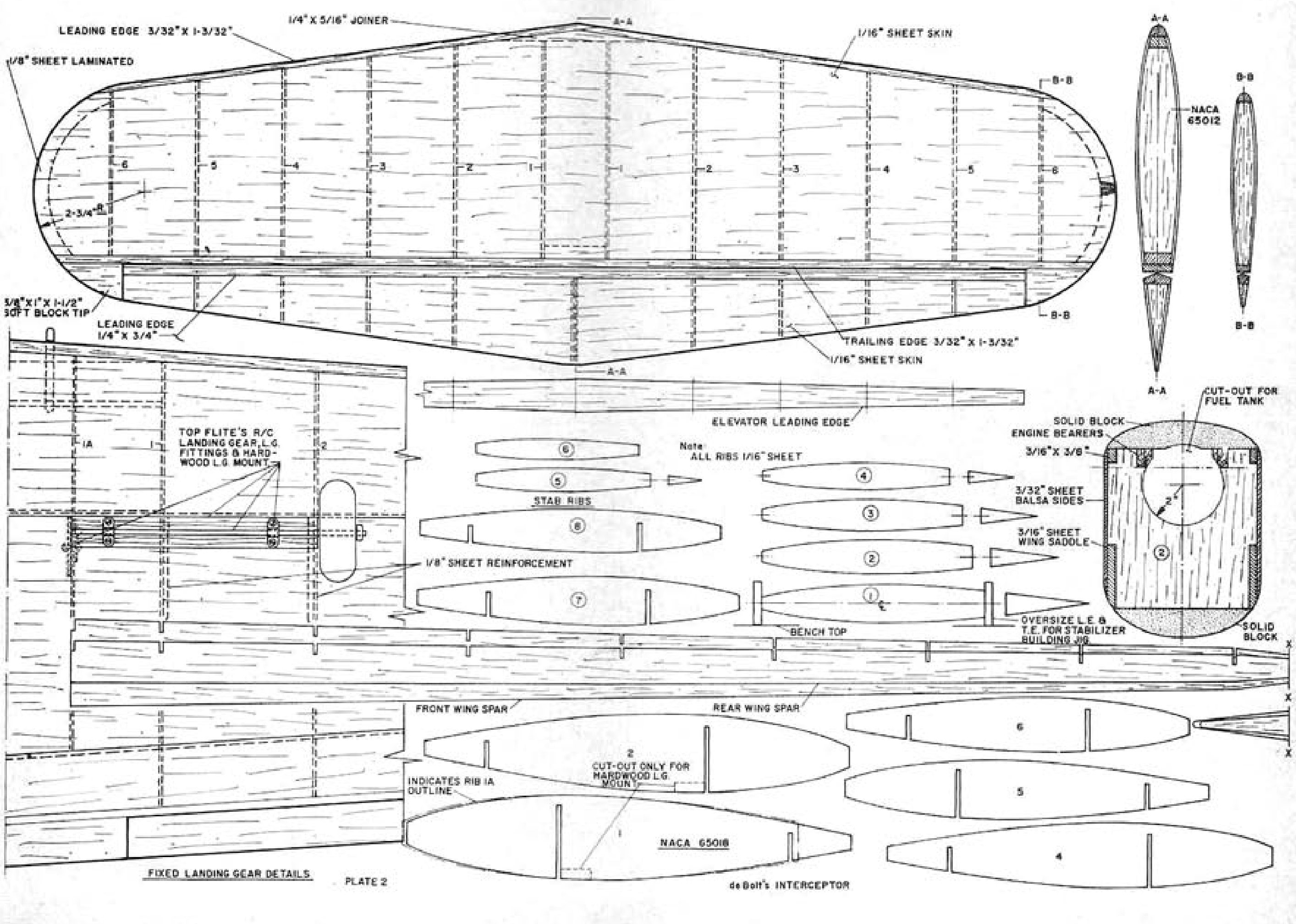
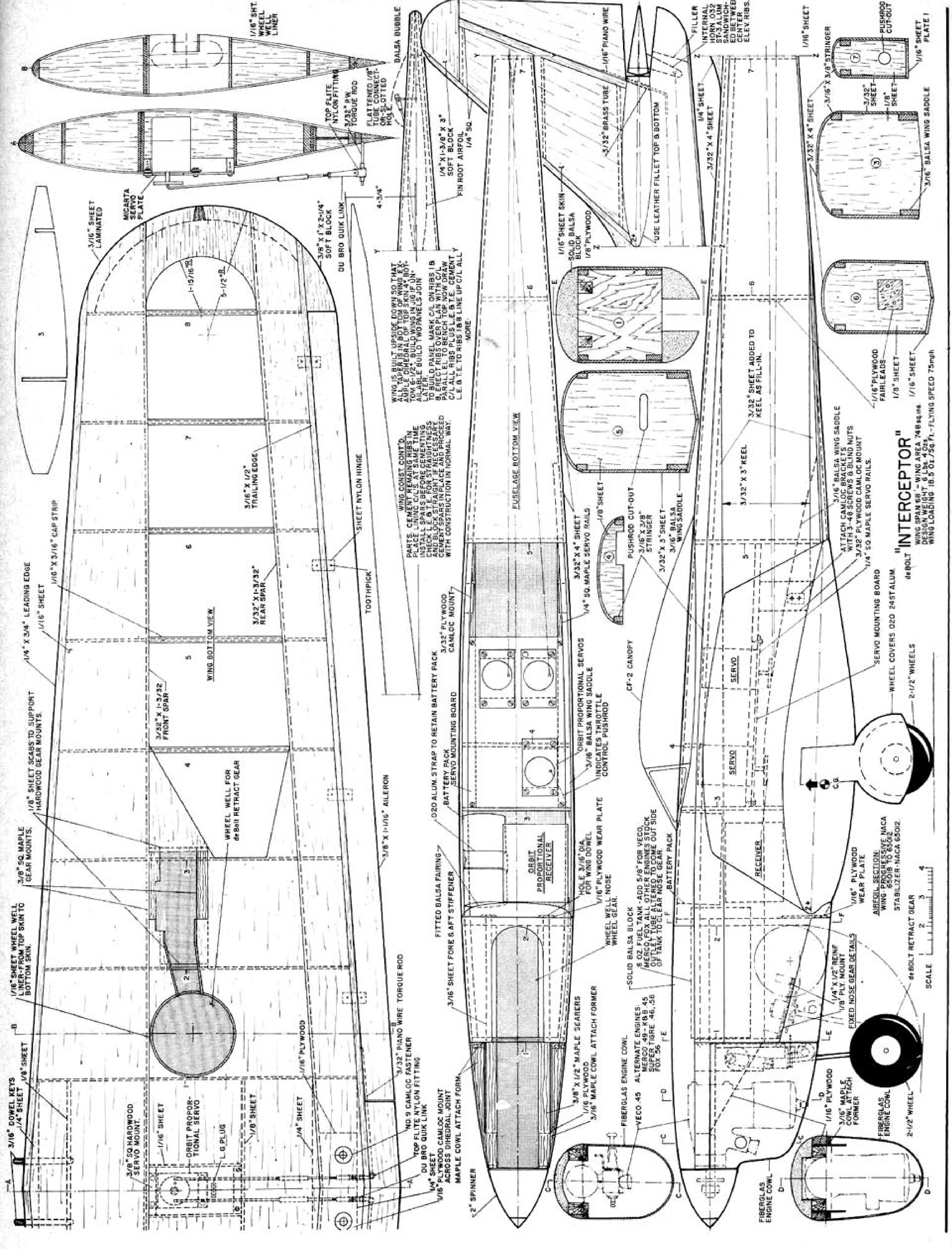
is aptly named when you watch it reaching for the sky, it just seems to m-o-v-e-o-u-t, no matter the direction or the speed of the wind. If you can imagine a model that is fast, smooth and at the same time, groovy, you will have some idea as to its performance. It seems that it is the sort of machine that is not being held back in any way, and looks like it wants to go and for once, looks are not deceiving for go it does.

Obviously, this is not the type of machine to duplicate the air show work of the Cole Brothers, Bill Adams, Harold Krier or any of the others who perform so well with their aerobatics. However, if you are one of those who admire the precision and spectacular flying of the Blue Angels, this is one airplane which can come pretty darn close to duplicating their feats.

I can frankly say that I have never been so happy in many a moon with the all-around performance of any design as this plane. When properly trimmed, there is no maneuver in the schedule which it will (*Continued on page* 46)

Main gear uses wheel well covers, nose gear wheel well is uncovered, needle valve is only projection in breeze when model is in full flight. Note Camlocs used to hold wing in place.




"INTERCEPTOR"
de BOLT
WING SPAN 68" - WING AREA 748 sq.ins.
DESIGN WEIGHT 6 Lbs. 4 Ozs.
WING LOADING 18.5 Oz./Sq.Ft. - FLYING SPEED 75mph
WING BOTTOM VIEW
FUSELAGE BOTTOM VIEW
WING IS BUILT UPSIDE DOWN SO THAT ALL TAPER IS ON BOTTOM OF WING. EXAMPLE: BLOCK UP T.E. OF TOP SKIN 6-1/2" FROM BOTTOM. BUILD WING IN JIG IF AVAILABLE. BUILD TWO PANELS JOIN LATER.
WING CONST. CONT'D.
AIRFOIL SECTION: WING-PROGRESSIVE NACA 65018 TO 65012 STABILIZER-NACA 65012
deBOLT RETRACT GEAR
SCALE
FIXED NOSE GEAR DETAILS
ORBIT PROPORTIONAL RECEIVER
ORBIT PROPORTIONAL SERVOS
BATTERY PACK
SERVO MOUNTING BOARD
CF-2 CANOPY
2" SPINNER
FIBERGLAS ENGINE COWL
VECO 45
ALTERNATE ENGINES: MERCO 49 - K&B 45 SUPER TIGRE 46,56 FOX 56
8 OZ. FUEL TANK
2-1/2" WHEELS
WHEEL COVERS 020 24ST ALUM.
3/32" X 1-3/32 FRONT SPAR
3/32" X 1-3/32" REAR SPAR
1/4" X 3/4" LEADING EDGE
3/8" X 1-1/16" AILERON
3/16" X 1/2" TRAILING EDGE
WHEEL WELL FOR deBolt RETRACT GEAR
BALSA BUBBLE
FIN ROOT AIRFOIL
USE LEATHER FILLET TOP & BOTTOM
3/32" X 3" KEEL
3/16" BALSA WING SADDLE
TOOTHPICK
SHEET NYLON HINGE
DU BRO QUIK LINK
MICARTA SERVO PLATE
TOP FLITE NYLON FITTING

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not do close to perfection. In competition you can easily expect a score of 9 and 10 points for both types of loops which is a bit rare these days. If you don't get 10 pts. for the rolls, you can blame only yourself as it will string them prettily if you will only let it have its head! One of the nicer things I heard about the design was from Zel Ritchie prior to the Nats. Watching a practice flight, he said, "Gosh, I wish I had me one of those things, with an airplane like that I sure could make some smoke!"

The question now could be, what makes the Interceptor go? The basis of the design, in a nut shell, is minimum of drag, exceptional stability and maximum of efficiency. If a model is to fly easily through the air, penetrate strong winds and maneuver cleanly, it must not have anything holding it back, thus drag is important. With the Interceptor, more than normal attention was given to reduction of drag, obvious of course is the retracting gear, engine cowl, Cam-Loc wing fastenings, and enclosed push rods. As a matter of fact, the only thing which protrudes from the model in flight is the needle valve and the switch handle! Other things which are not readily noticed are the force arrangement, wing and tail planforms, and most important the airfoil.

Of course, it is easy to see that if drag is low the model will fly faster. What may be a bit harder to see if this is true, is that the model will also maneuver easier and cleaner. Maneuverability controlled by the amount of lift present. If we have considerable lift available, all that is required is to couple it with the controls and our model will literally fly through the maneuvers. Unfortunately in the process of using the additional lift, the drag goes up astronomically. This will tend to slow us down with the resulting loss of lift and a vicious circle starts and would result in loss of maneuverability. It is obvious that the lower the drag at the start of a maneuver, the less it will be at the end, result can only be improvement. In practice what seems to happen is that with reduced drag, the model requires less lift which further reduces drag during the maneuver. The best proof is that the Interceptor is my first model that does not depend a great deal on power for maneuverability, fact is it will fly equally as well with the engine in a complete four cycle or at full bore, the only difference being a reduction in level flight speed.

A model can also develop drag from its flight attitude as well as its shape. If it is the type which "hops around" in the air, then each change in attitude is going to add drag, because the profile presented to the airflow is something other than the necessary minimum. Therefore, it is extremely important that the model should possess amply stability. Force arrangement used tends to be extremely stable and the angles were chosen to obtain the necessary lift in level flight at the best possible lift/drag ratio for the airfoil.

I am of the school of thought which insists that our stabilizer must create lift and if arranged correctly, it can be used to combat the changes in lift created by the wing at various flying speeds. It is a fact that wing lift goes up as a square of the speed and if provision is not made to balance this, our model will climb or dive every time the speed changes, therefore the stabilizer is at a positive angle and it is lifting at all flight attitudes. Stab airfoil was choosen so that its lift potential at the positive angle is just enough to keep the wing in balance as the speed changes. Result, a model which flies flat through all speed changes, requires little if any change in trim during the flight and thus has a minimum of control surface drag.

Thrust line it important to our force arrangement, it is a rather high one and only at this location will it compliment the rest of the force arrangement. An additional asset of the high thrust line is that when the plane flies inverted, it appears to cancel out a lot of the positive effect from the wing and tail with the resulting effect that the model flies equally as well inverted and *WITHOUT* trim changes.

Thus, this force arrangement gives the model the stability required for smooth flight, while at the same time it adds to the drag reduction, serving two purposes.

Efficiency is a word I often use in describing an approach to a design. I always say the more efficient the model, the closer it is to being the best, and yet the word itself can be extremely vague. Just how do you go about getting the model to be efficient? My definition is to get the "mostest" from what we have to work with. If we were to build a model with more lift and less drag, we could maneuver it better but in turn, this would mean a larger size airplane and would require more power to fly it. Naturally, we do not wish

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to go beyond a certain size model and for economical reasons more than anything else, we wish to use a reasonable size engine. So in this case we tried for the greatest potential from what we have. This is done by always effecting the most aerodynamically efficient way, without regard to construction problems, cost or maintenance. The Interceptor is a more complicated machine but because of this, the potential is greater in turn.

The only thing which makes an airplane fly is the wing and as a result, the wing is also the major producer of all good and evil in a design. It should be obvious that as far as flying is concerned, a model can be only as good as the wing used. For this reason a considerable amount of research was put into the Interceptor's wing design. With efficiency in mind, we attempted to determine what planform would be the most stable, create the least drag and develop the most lift from a given area. Then we studied airfoil charts to find a foil which would best fit our needs, keeping in mind that we must fly inverted as well, without need of maximum lift but would like all we can get without creating exceptional drag.

Wing planform used is about as old as a planform can be, nothing startlingly new here or from the space age! I think that I first admired the shape of Wiley Post's Winnie Mae and we all agree that it was a pretty airplane, if nothing else . . . . Actually, a lot of thought went into this simple shape and structurally it is a pyramid which certainly has strength. Aerodynamically, it is a neat taper with some sweep back effect.

So, what advantage does sweep back

offer? This appears to improve the directional stability and it means better loops in most cases; however, too much will create yaw problems which required abnormal fin area to overcome. It's nice to have a little but not too much.

I think we agree that a taper wing is pretty, but what else does it offer for the extra work? First, it allows us to use higher aspect ratio which adds to the efficiency of the wing. It does this without moving the center of wing area further from the axis of the model than that of a straight chord wing of a lower aspect ratio. This means that the roll rate and stability should remain the same in spite of the increased span.

With a constant chord wing, the CG and center of lift of each panel are going to be somewhere near the one-half way point spanwise, actually even a bit closer to center due to the tip effects. With the taper it will move inboard and become much closer to the CG of the airplane. Closer grouped forces adds to stability and also allows the model to maneuver better.

The equal taper, as used with the Interceptor, seems to have some advantage in rolls. The reason is, that as the wing rotates in the roll, the new forces which are generated by the rotation fall more or less down the center line of the wing's planform. Sweep the wing back or forward and these forces act differently at the tip then they do at the center; this effect can cause some yaw problems in the rolls.

One marked advantage of taper in our case is reduction in drag and the fact that the taper moves the center of drag of the wing much closer to the fuselage with once again added stability and maneuverability. The taper decreases drag by making the wing tip chord as small as possible. A considerable portion of the drag of a wing comes from air spilling from top to bottom at the tip. This effect, plus the tip, create strong vortices that have a high drag potential, naturally the smaller the tip the less drag. We also used a rounded top to further help as this effectively reduces the size of the tip. Note that all control surfaces end before they reach the tips. This is also done for a reason: it is to remove the control surfaces from the area where these tip vortices occur. Whenever you move a control surface, drag is created and with the drag comes vortices. When these surfaces are also at the tip of the panel, you then have the control surface vortices present. PLUS that of the tip. Compounding the problem and it is possible that unequal conditions can be created with a resulting yaw tendency. Example might be the fact that the vortices could differ when created by up and down aileron. If so, you would have unequal drag on the wing whenever ailerons are used.

Airfoils used are the NACA 6500 series which is fully symmetrical and a finely developed modern series airfoil ideally suited to our needs. They have no bad characteristics whatsoever, have a high lift potential, extremely low drag plus being exceedingly stable. Could you ask for more? A bonus which you bet with this section is that is lifts equally as well inverted as upright and only very small changes in the angle of attack will shift it from positive to negative lift. This means that it is possible to fly either upright or inverted without drastic trim changes to get the required lift for inverted flight. Apparently, it is even possible for the force arrangement to bring it about without resorting to trim.

This same effect from the symmetrical section is an advantage during our horizontal rolls, much less elevator action is required to keep the rolls on an axis and practically no jaw occurs during the maneuver.

To the best of my knowledge, the Interceptor also pioneers the use of progressive airfoils in our R/C stunt models. A wing has a progressive airfoil when the section at the root is *different* from the one used at the tip, this is the difference between a tapered airfoil and a progressive one. In this case, we used a 65-018 at the root progressing to a 65-012 at the tip. The average thickness of the section then becomes 15%. According to NACA reports, the most useful thickness range for airfoils is from 12 to 15% when applied for our purposes. We have come to like the higher portion of this range and have found no advantage in anything thicker.

Construction of a wing with progressive airfoils is naturally more complicated as there are no two ribs in a panel which have the same airfoil shape. In view of this, there must be good reason for using progression, otherwise how would you be "paid" for this additional effort? It should be pointed out that all modern full scale aircraft use progression as a must in their design.

The theory is this: A progressive airfoiled wing has greater tip stability, the center of lift and drag is moved closer to the center which in turn, adds to stability and maneuverability and the drag at the tips is further reduced. This tip stability helps keeping the airplane more stable in gusty air and when approaching the stall angles. The reduction of drag at the tips increases directional stability plus allowing the airplane to turn easier about its center point. So, it can be seen that by the use of progression, plus taper, a much more efficient wing can be had.

Choice of airfoil is most important when progression is use, otherwise the progression has no value. The idea is to use an airfoil for the root which has a very desirable lift- drag ratio, one which creates plenty of lift at the least drag, stability of the airfoil can be a secondary consideration. To accomplish the objective it is then necessary to choose a airfoil for the tip that has greater stability and less drag than that of the root section. In doing so, you come up with a tip section which has less lift potential, but the other advantages generally outweigh this sacrifice. Quite often, to accomplish these objectives you must use airfoils of two different families, i.e., a Cessna uses a 2400 series airfoil at the root, and changes to a full symmetrical at the tips. This makes sense as the 2400 series is a good lifting section but rather unstable. In turn, full symmetrical has a great amount of stability accomplishing its purpose nicely. You will find all the other factors mentioned also present in this combination. For the Interceptor, we were rather lucky as we were able to come up with two airfoils from the SAME family which provide exactly the desired conditions. There is just enough difference in the characteristics of the 18% and 12% sections to do our job. The advantage is that you have a most desirable airfoil throughout the span of the wing, whereas when you change from one family of airfoils to another one you sometimes rather have weird shapes as the progression occurs.

Even if you don't agree with all this hogwash, I will bet that you will like the appearance of the Interceptor wing, if nothing else progression of this sort makes a mighty pretty shape to look at!

In conclusion, I suppose I should say that the Interceptor is just about the ultimate in multi-R/C design, but somehow I find this hard to believe. I do believe that

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the ideas which have gone into this design, are on the right track and the result is exceptionally well worth while, however progress never seems to end and I doubt seriously if it will here. For example, many of these ideas could be applied in a different way and have a design to fit the "slow school of thought". Wonder what would happen as a result?

If you are a person who enjoys fine things, a spectacular flying model and one which can catch the judges' eye, give the Interceptor a try. I think you will like it!