YANKEE

The perfect airplane? A guaranteed winner? The secret way to the top? / by Bob Noll

Don't believe it. There is no pattern design that can provide instant success and overcome a lack of flying talent on the part of the pilot. No matter what you may think, winning is made up of 90% pilot ability, 5% airplane and 5% luck. And in today's highly competitive sport of pattern flying, it is most important that as much effort as possible be put into the 95% that we can control. Practice, practice practice with a good, honest airplane is the answer.

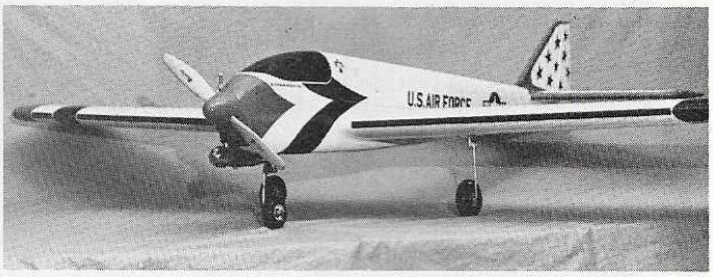
Of course, there are many good plane designs kicking around the country, such as the Tiger Tail, Mach I, Daddy Rabbit, Cutlass, Kaos, Banshee and others. In the hands of a top pilot, all these designs can be found in the winners circle, primarily because they are sound designs with very honest flying characteristics.

The Yankee is an attempt to achieve a plane which contains both soundness and honesty, as well as a high degree of smoothness in all maneuvers. Having

ABOVE: A clean design, the Yankee features proven concepts in solid construction.

LEFT: Practice, practice, practice with a good, honest airplane is the only key to success in pattern. The Yankee was specifically designed for longevity and reliability.

BELOW: Flowing, unbroken lines, accentuated by a striking and spirited paint scheme are essential for high points—the judges pay more attention to a sharp-looking plane.



used these terms, let me explain what I mean.

Soundness in design has to do primarily with functionality and integrity of construction. Good basic construction practices, proven reliable over years of experience by other successful designers and myself, have been applied to the Yankee design.

Honesty in flying characteristics relates to the plane's predictability, with a primary emphasis on repetitive duplication and absence of the unexpected. It's hard enough to master the pattern maneuvers without having to contend with a plane that has some nasty idiosyncrasies.

Smoothness is self-explanatory, but a factor not given enough thought with respect to the plane. Although the pilot's "habits" contribute significantly to the smoothness of flight, the plane, design, and setup are also key factors.

The Yankee definitely meets the criteria mentioned above. It has performed well for me during the contest season, during which time the design was refined through some changes.

As I am not an aeronautical engineer, I can't take credit for developing exotic new airfoils and other aerodynamic breakthroughs in the Yankee. However, being a competitive modeler for quite a few years, I have built this design around some basic good experience that I have had with a Jet Star Mk7 by Ed Keck, and the famous Cutlass Supreme by Don Coleman. In addition to having flown these two designs in competition, I have had the opportunity to fly some of the other popular designs over the past few years, and feel that the Yankee is capable of performing with the best.

Although I will provide some of the significant design features of the Yankee, I want to impress you with the need to build an accurately true and well aligned plane in order to take advantage of the design characteristics. Every competitor who is at, or near, the winners' circle understands the need to have a plane that is exactly true and totally free from warps, surface irregularities and misalignments. And believe it or not, it isn't much more work to do the job the right way; the benefits will be impressive. Each plane I build reconfirms my awareness about the importance of building accuracy.

Now let me go into some of the design features in the Yankee. Both the Jet Star Mk7 and the Cutlass Supreme have the wings 1" below the thrust line. This configuration has worked well in both these designs, so it was retained for the Yankee. Some designers argue that the wing is harder to see as it is moved up toward the thrust line since, in flight, it becomes masked by the fuselage. I have not experienced this problem, however, as I have always used a contrasting strip along the entire wing leading edge to make it stand out. Moving the wing closer to the thrust line can present equipment installation and landing gear problems. The Yankee uses a compromise and, besides, 1" is easy to measure. The stab is 1" above the thrust line, which places it adequately above the wing, thus preventing turbulent air over the wing from effecting the pitch sensitivity and elevator control during the landings.

The nose and tail moments of 14" and 28" respectively are quite conventional, providing a ratio of 1:2. The nose moment may appear to be much shorter, because of the straight trailing edge wing planform.

Speaking of the wing, its area is 700 sq. inches with a span of 64" and a mean chord of 11.4", yielding an aspect ratio of 5.6. The root section is 15% symmetrical, and the tip section is 15% semi-symmetrical. Leading edge sweep is 7° and the trailing edge is straight, which results in a swept mean chord line. The reason for the straight trailing edge planform is very simple. It adds to the effective wing dihedral in both upright and inverted flight. The need for built-in dihedral is therefore reduced with this configuration, which is an advantage in rolling and inverted maneuvers, such as outside loops. A slightly lifting section is used at the tips to prevent tip stall, so common with swept wing designs when the angle of attack is increased during landings.

The Yankee wing has a sharper leading edge than either the Jet Star or the Cutlass Supreme. This was done to increase pitch sensitivity, in order to have a plane that grooved better than the more blunt leading edge planes. It is true that a blunt leading edge wing provides softer response to pitch control; however, the tremendous resolution of our current servos provides smoothness without the need for the blunt leading edge wings. One of the paramount improvements realized in the Yankee is the way it "locks in" on a heading and stays in the "groove."

The horizontal stabilizer has an area of 167 sq. inches which is 24% of the wing area. It uses 12% symmetrical section, which makes elevator control very smooth but positive, even at extremely slow landing speeds.

One problem with the Yankee, as it

was originally built, was that rudder deflection caused a rolling tendency. This is very undesirable, since the effect of rudder control should be pure yaw, so as not to harm the Four-Point Roll, Slow Roll and Figure M maneuvers. In order to obtain the desired yaw, the rolling effect of the rudder should be equal and opposite to the rolling effect of the dihedral.

There are two approaches to solving this problem. One is to change the center of pressure of the rudder/fin combination by moving it farther above the roll axis. The other is to reduce the dihedral.

Making a new rudder with a constant chord is easier than cutting up a wing, so this approach was taken first. This change was made by a good friend and competitor Larry Detwiler, who was also flying a Yankee, but the results were less than satisfying. The theory appeared to be correct, since the roll effect of the new rudder with a higher area was decreased; however, not enough to meet our objective.

The next thing to do was reduce the dihedral. After considerable research and deliberation, I was convinced that it had to be done. Several nights were consumed carefully planning out the "operation" and finally, the first incision was made. As it turned out, the job was done in half the time it took to think about it. The dihedral was reduced to half of its original amount.

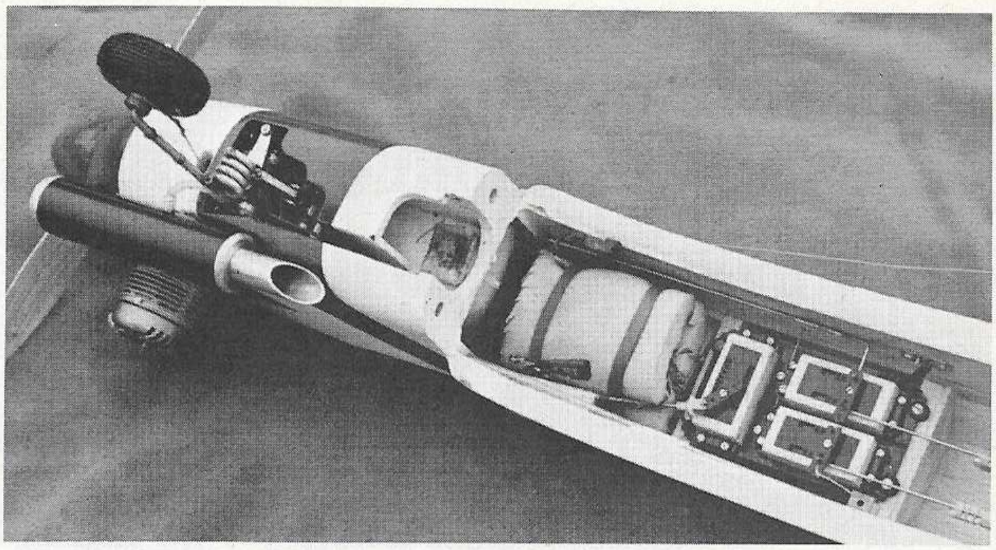
You can probably imagine how anxious I was to get out to the field and find out whether the operation was a success. Well, the results were tremendous. Not only were the Four-Point and Slow Roll maneuvers easier to do, but the Figure M showed significant improvement also. One fear, however, was how the reduced dihedral would effect the tracking in loops. Fortunately, I could see no difference and, in fact, crosswind loops were better since rudder corrections were more effective.

One complaint I had with the Cutlass Supreme was its desire to weathervane in a strong crosswind. Others have also commented about this problem, and it is caused by the large lateral tail area. Therefore, the Yankee was designed with less lateral tail area. As a result, the crosswind characteristics are very acceptable. The lateral area in front of the CG was also increased slightly for the same reason.

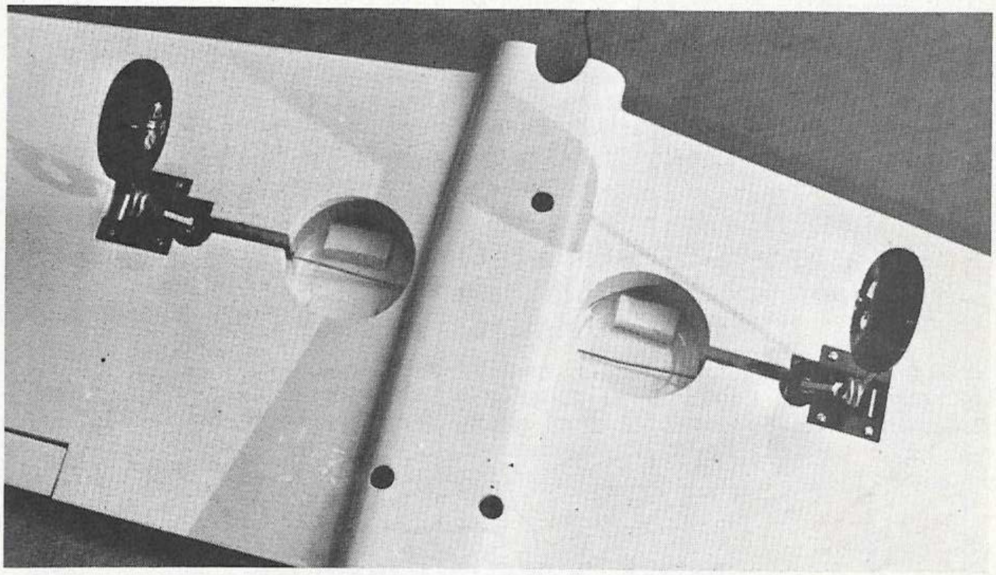
Now let me discuss some of the construction features used in the Yankee, and explain why they are used. I believe they contribute to a "sound" design, and most of them can be applied to any plane design.

Starting at the front, you will notice that the engine is side-mounted and on maple beam mounts. Both these things were done to reduce vibration, a culprit that can mean disaster if it is not controlled. By side-mounting the engine, the vibration forces are absorbed adequately by both the wing and the fuselage. The maple beam mounts are tied into the fuselage sides with pine filler blocks and to the top nose block, so

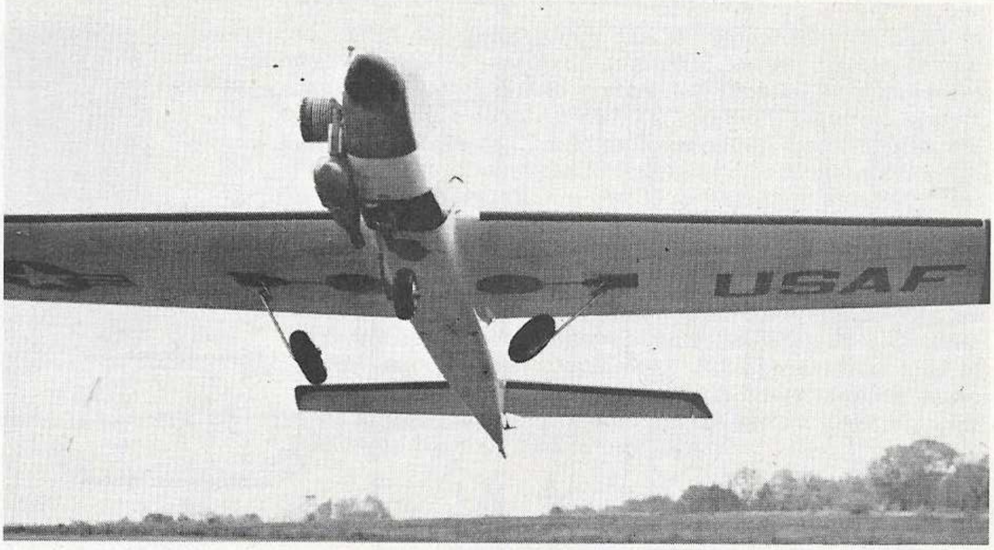
(Text continued on page 92)
(Plans on following page)

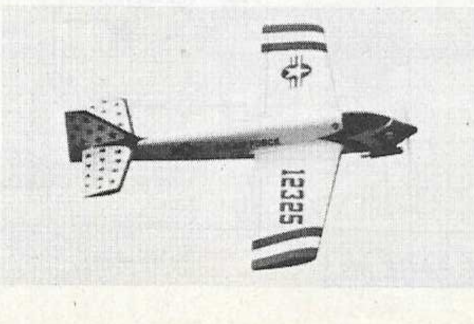


Typical installation.



Margarine containers make simple wheel well bottoms. Foam rubber strips absorb vibration. The hole in the belly pan is for access to the nose gear bellcrank.





ABOVE: Up, up and away. A single 180° servo and an unique linkage retract the gear. LEFT: The Yankee in action.

YANKEE

(Continued from page 53)

that a minimum of power is lost from the roaring power plant hanging on the front. Not only is it smart to reduce vibration so that a maximum of power is obtained, but also to protect the radio equipment and integrity of the fuselage. No one likes to have cracks show around the firewall half way through the season.

I am using muffler pressure. A small

bonus to a side-mounted engine is that the tank pressure line does not have to be disconnected from the muffler when filling the tank. Just let the overflow drain out the end of the muffler.

Tank location is critical for optimum performance, and the Yankee's fuel tank is located so that its center line is exactly in line with the engine carburetor center line. This location of the 12-oz. tank does prevent the nose wheel from being completely hidden in its retracted position, but first things first, and that means tank position before looks. Two other features of the tank installation are that it is removable for service without a hatch. An access hole in the front of the tank floor allows inspection of fuel lines to insure they are not restricted in any way.

Next to the tank, and mounted inside the fuselage side, is an important feature of the nose gear stearing linkage. I have shown a pictorial view on the plans to help explain the construction. A problem with designs in which the wing is pushed up into the fuselage nearer the thrust line is to provide an adequate stearing linkage to the nose gear, since it can seldom be accomplished with a straight line pushrod. A common solution is to use flexible cable in tubing but I have found this to be inadequate, because a zero slop condition cannot be obtained.

The linkage in the Yankee provides the precision of a single straight pushrod, while accommodating the misalignment between the rudder servo and the nose gear stearing arm. It is very simple, and only two factors must be achieved. One is that the 1/16" wire from the rudder servo must be rigidly supported at two bearing points no more than 1½" apart. These bearing points are the plywood former F-2 and a hardwood block glued to the fuselage side, both of which have clearance holes for the 1/16" wire pushrod. The second factor is a 1/2" wide strip of sheet brass of .032 thickness which is soldered to the ends of the wire pushrods. Bend the ends of the brass strip around the wire to insure a solid joint. I think you will find this linkage rather simple to make and free from unwanted play.

Moving toward the tail, the next thing worth mentioning is the fillet construction. Large wing fillets are important in reducing turbulence, as well as providing a good bearing surface for the wing—not to mention their aesthetic value. I've made fillets from balsa blocks and completely from fillet materials such as Epoxo-lite or micro-balloons in epoxy or resin. The technique used on the Yankee, however, has proven to be the most simple and lightest in weight. These fillets are made of foam covered with a thin coating of Epoxo-lite. After the wing is properly aligned to the fuselage and secured with the conventional dowels and 1/4-20 nylon screws, a fillet saddle of 1/64" plywood is layed on the wing and butted against the fuselage side. Then several rough-cut blocks of foam are glued in place. A few minutes with coarse sandpaper wrapped around a large dowel and then a light coating with Epoxo-lite is all that is required.

The main landing gears are mounted on 3/16" plywood plates, which are recessed into the foam wing core. In the past, I have spent much time with maple rails and plywood ribs to provide a main gear mount. Not only is the 3/16" ply plate totally adequate, but it is lighter and faster than the inlaid hardwood rails. If you are accustomed to making hard landings, or flying from extremely rough surfaces, you may want to drill through the plates at two locations and insert 1/4" dowels through the plates to the top wing surface. I have not found this to be necessary, however.

All three Pro-Line retract gears are operated by one 180° servo mounting in the wing. This can also be a problem when the wing is near the thrust line, since the nose gear is considerably lower than the top of the wing, where the main gear linkage and retract servo are located. My solution to this problem is to use a straight bellcrank to transfer the nose gear pushrod action from the servo at the top of the wing to the lower nose gear. The homemade bellcrank is mounted to a substantially large maple block, which is glued directly into a hole in the foam wing core. This hole extends completely through the core, from top to bottom, and is large enough to accommodate the bearing block and the motion of the bellcrank. The bellcrank extends from just beneath the top wing skin through the bottom wing skin. The 1/16" wire pushrod from the nose gear attaches to the bellcrank below the wing and within the center filler piece. It exits the wing through a hole below the leading edge. A pictorial sketch is included on the plans for clarification.

While on the subject of landing gear, I will mention two other items. One is to be sure to place pieces of foam rubber in the wheel wells to absorb vibration when the wheels are retracted. This vibration is a significant cause of retract gear wear, since more time is spent with the gear up when the engine is running than with the gear down. The second item is a simple way to provide a neat appearance to the bottom of the wing wheel wells—if you really care, that is. I found that the bottom of plastic margarine containers gives a nice finishing touch to the wheel wells. They are very lightweight.

Very important factors in achieving a plane with smooth and precise control response are the way the control surfaces are fitted and hinged. Ailerons, elevators and rudder must be shaped so that they are an exact continuation of the mating surfaces. Also, hinge line gaps must be kept to a minimum, preferably zero, since the slightest gap will cause a reduction in control response, along with increased drag.

In order to achieve a perfect fit for my control surfaces, I use the following procedure. I always start with sheet balsa of adequate thickness. Trailing edge stock is never the correct taper and, what's more, it's more expensive. Cut the sheet to the proper width or chord, then insert at least three hinges per surface, being sure that they are in a straight line. Do not permanently glue the hinges at this time. Now tack-glue the sheet stock in place with hinges inserted. Shape the ailerons, elevators and rudder with a razor plane and sanding block until they are to the same contour as their respective mating surfaces. When the shaping is complete, break the surface loose and remove the hinges. With a straightedge and razor plane, shape their leading edges to a V so that the correct amount of control deflection can be obtained. When the surfaces are finally hinged in place you will find that they fit precisely and will provide maximum performance.

As I said earlier, keep the hinge line gap to a minimum when securing the hinges. I find that this is best accomplished by using the "no-pin" hinges. However, if a pinned hinge is used, be sure to recess the hinge enough to eliminate the gap, and be careful not to get glue into the hinge point.

It may not seem important to most builders to worry about hinge line gap. However, I can assure you that its importance is very significant in obtaining good control response on your plane. The whole idea is to prevent air from flowing through the hinge line, thereby reducing the control response. Have you ever had a plane that required a large amount of surface movement before a satisfactory degree of control was obtained? If so, check the hinge line gap and if you're too lazy to re-install the hinges properly, place a strip of tape or MonoKote along the hinge line and see the difference. You may be surprised to find that the necessary deflection can be reduced by half, while maintaining the same control response. This greatly reduces the drag from the deflected surface.

For those of you who are interested in specifications, I have tabulated the following information:

WING

Area—700 sq. inches
Span—64"
Mean Chord—11-3/8"
Root airfoil—15% Symmetrical
Tip airfoil—15% semi-symmetrical
L.E. sweep—7°
Dihedral—3/4" each tip; 1½" total
Aspect ratio—5.6

STABILIZER

Area—167 sq. inches (24% of wing)
Span—26"
Mean Chord—6¾"
Airfoil—12% symmetrical
Aspect ratio—3.9

FUSELAGE

Length—46"
Nose moment—14"
Tail moment—28"

WEIGHTS

Wing—2 lb. 2 oz. without servos & landing gear
2 lb. 12 oz. with servos & landing gear.
Fuselage—2 lb. 2 oz. without engine,

radio & L.G.

4 lb. 12 oz. with engine, radio & L.G.

Total flying weight—7½ lb.

CONTROL DEFLECTIONS

Aileron—1/4"
Elevator—3/8"
Rudder—1½"

MISCELLANEOUS

Landing Gear Thread—16"
Incidences—Wing 0°; Stab 0°
Power—Webra 61

Everyone has his own favorite finishing techniques, and I'm no different. Since the procedure I use may be different from most, I'll explain it briefly. First of all, there is only one coat of dope on my plane and that is used for the sole purpose of attaching the silk to the fuselage and the silkspan to the wing and tail surfaces. I start by sealing the wood with one coat of clear epoxy paint. When this is dry, it is sanded lightly to remove all whiskers. Then the silk and silkspan are attached with one coat of thinned clear dope.

After the dope has thoroughly dried for at least 24 hours, two more coats of clear epoxy paint are brushed on and scraped to a smooth finish with single-edged razor blades. Now you are ready for the epoxy primer and then color (sprayed, of course). I use this finish for several reasons. It is light, the absence of dope prevents shrinking and therefore seams don't show as much and, lastly, the finish is very durable and fuelproof. It's great if your wife can't stand dope fumes, too.

Well, thats about it. I hope you will build the Yankee and join in the fun of pattern competition. Build it carefully, and then practice—your contest experience will be rewarding. I also hope that the few construction tips that I have mentioned will help you be a better modeler and build a better Yankee.