

DART III

By Captain Charles T. Winter, U.S.A.F.

WHY the "Dart III"?

It's like asking, "Why do we need a good five-cent cigar?" The Dart III concept was originated out of the frustrations of a model builder who believed that the majority of radio control model airplanes being built and flown today are lacking both in creative design and construction.

I have been building and designing model airplanes for over 20 years. During the mid-forties, when I was an avid U-Control enthusiast, I was directly involved with the development of the aluminum speed pan. A design called the Hell-Razor, which terrorized the contest circuit for many years and reached the then unheard of speed of 159 MPH on two .016" wires for the world speed record, was designed by

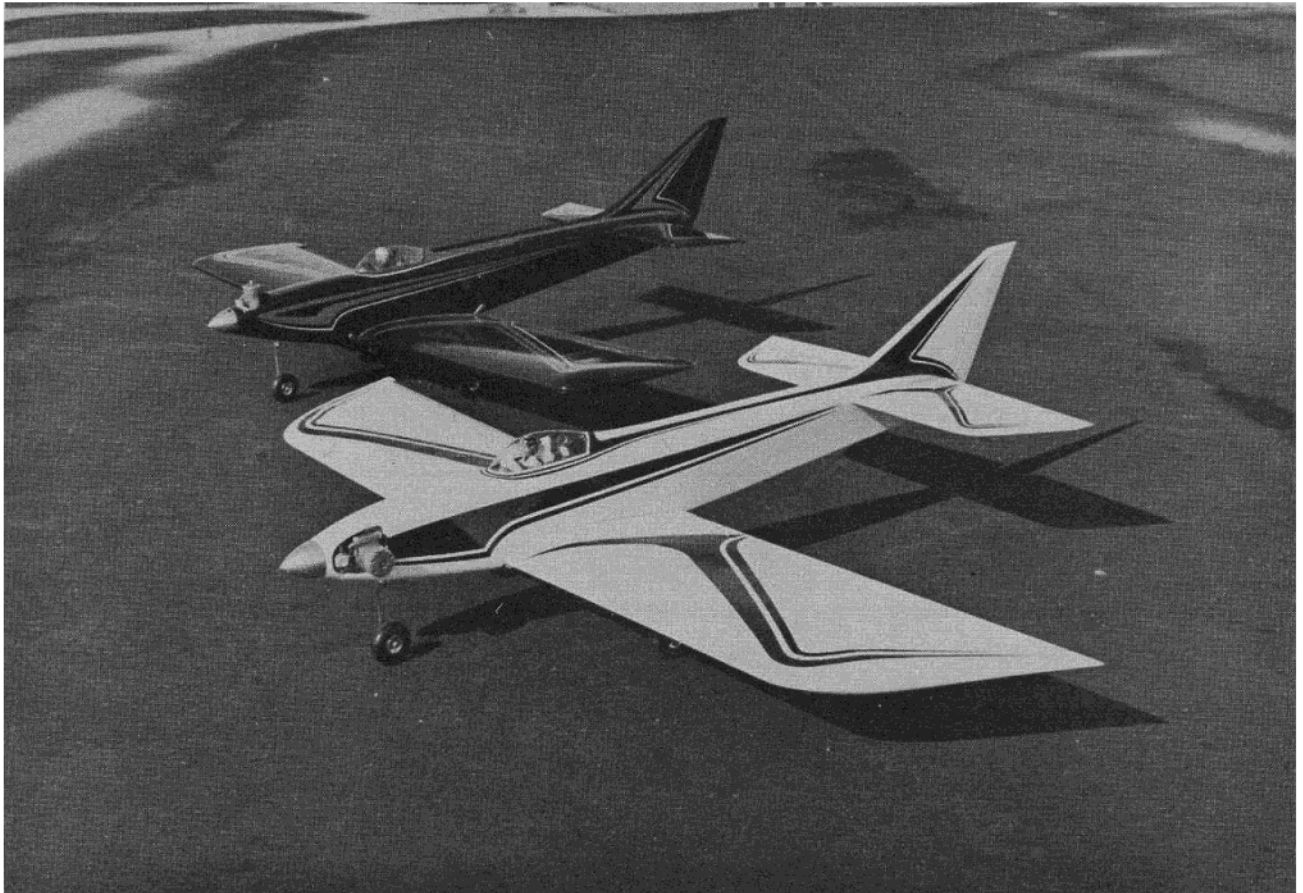
George Fong, Fletcher Slade, and myself.

My credentials include a college degree in Mechanical Engineering, plus a year of Aeronautical Engineering. After finishing school, I worked for Republic Aviation, Long Island, N. Y. The project to which I was assigned at Republic was development of the hydraulic and control systems of the F-84F jet fighter. After one year with Republic the jet engine roar got to me, so I tried my hand at making some noise myself by joining the U. S. Air Force. I have since logged over 3,000 hours in 13 years of flying jets.

I feel I should mention at this point that I hold the unofficial world model airplane speed record; a window-rattling 860 MPH. I accomplished this momentous feat by taking one of my Hell-Razor

speed planes with me during a supersonic mission in an F-86D all-weather interceptor! I guess I hold the altitude record for model airplanes too — 45,000 feet. At present, I'm flying F-106 all-weather interceptors and could easily increase my speed and altitude record, were they ever challenged!

Let's get back to the reason for this article, "Why the Dart III?" During the preliminary design layouts, I wanted an airplane into which any radio control equipment could fit, plus additional room for those thick, clumsy fingers that can never reach that elusive little do-dad that needs adjusting or tightening. The radio and servo compartment measure a spacious 3½ inches wide, 13½ inches long, and plenty deep. It is also designed to allow the servo tray to extend into the fuel tank compartment. This permits



mounting the battery pack on the servo board. You can now change the entire radio-servo package from one plane to another without that unpleasant job of digging the battery pack out from under the fuel tank.

The question most frequently asked by fellow model-builders is why I have designed the wing and horizontal stabilizer with swept tips. My first reply to this question is, "Why not?" The aerodynamic reason is that I have combined the desirable characteristics of both the swept and straight wing. The low speed handling of the "Dart III" is nothing short of outstanding. The swept tips aid in yaw stability by increasing the drag on the tip that may move further forward due to yaw or slip encountered accidentally or on purpose. At high speeds, the "Dart III" will fly a perfectly straight line, called "grooving" by many model builders.

The over-all flight stability is enhanced by the effective vertical stabilizer area which starts from the rear of the canopy and develops from that point rearward. The length of the Dart fuselage is deceiving. It measures a surprising five feet from the nose to the furthest aft point on the vertical stabilizer. A look at the horizontal stabilizer will reveal nothing earth-shattering. The feature worth mentioning is the location of the horizontal stabilizer with relation to its moment from the aircraft center of

gravity. The tail moment has been designed to be short. This takes full advantage of the proportional type radio control equipment available today.

The fuselage construction is only slightly different than most. The engine was side-mounted to give a more aerodynamically clean appearance. I deplore inverted engines with their starting problems, and digging dirt out of the carburetor and cylinder head after an unscheduled bad landing. The side-mounted engine offers no problems. You can mount the engine on either side by simply flip-flopping the two engine mounting bulkheads when building the forward section of the fuselage.

A close look at the nose gear installation will reveal that it is mounted slightly off center to allow it to clear the motor mount. This offers no problem and is visually undetectable to anybody admiring your aircraft. Contact cement is used to hold the $\frac{1}{16}$ " plywood doubler to the balsa sheet sides. White glue is used extensively throughout the airplane except in areas that would allow the glue to create problems with the final painting. I will discuss preparation and painting techniques later in the article.

Initially, the fuselage is assembled by gluing the two plywood bulkheads that make up the radio servo compartment in place. You can also have the servo rails in place during this operation. Allow the glue to dry completely before

continuing. Temporarily put the forward nose gear bulkhead and motor mounts in place. The aid of "C" clamps are needed for this step. Use caution by placing pieces of scrap balsa under the "C" clamp contact points to eliminate the possibility of denting or crushing the balsa wood sides. Check all parts for alignment at this point. Adjust and trim motor mounts and plywood bulkheads to give you the recommended 0 (zero) degree engine placement. When you are satisfied that all parts have the proper alignment, white glue them. This last step is critical because once glued, you are committed to the position of your motor mounts. Allow these parts to set, in position, for at least 12 hours. From this point on, the basic fuselage construction is nothing more than installing and shaping balsa blocks. The canopy and dorsal fin installation will be covered with painting techniques.

The construction of the wing and horizontal stabilizer are straightforward and follow well-established construction principles. The wing airfoil is symmetrical, which I believe to be the most desirable airfoil for a Class III stunt aircraft. Theoretically, if you could have an airplane with the wing and horizontal stabilizer along the thrust line and a symmetrical airfoil with no wing dihedral, it should fly just as well inverted as right side up. An airplane as I have just described is what most good control

line stunt aircraft are designed around.

This so called (zero zero) designed airplane is not totally desirable for our radio controlled airplane. Most of our maneuvers are started and completed right side up. This means that it is desirable to give our aircraft more stability during its normal right side up flight. This is accomplished by slight wing dihedral (the Dart has the minimum amount of dihedral necessary for right side up stability). From the construction standpoint, the low wing is the most desirable. It allows for strong and efficient one piece wing with simple landing gear installation. The fuselage has a large cavity which allows for any type of radio control installation.

During inverted flight, the small amount of wing dihedral is not detrimental to flight stability. In fact, the fuselage weight is now located under the wing which has a stabilizing effect much the same as a standard high wing airplane. Filling the wing leading edge area with Polyurethane (Sig Super Foam) helps prevent wing damage transmitted by the fuselage, during that "one-in-a-million" bad landing! A precaution well taken when putting the Polyurethane mixed concentrate in restricted areas is to use less concentrate than necessary to fill the area in question. If too much concentrate is used in a restricted area, it will expand and bulge or possibly cause an open break in the area. It is safer to fill the area with two or more applications and monitor the expansion closely. It takes approximately one teaspoon of each chemical to fill one leading edge cavity.

Cam-Locks are used for ease of wing installation. I believe the installation I have in the Dart to be extremely strong and easily constructed. Dowels are prepositioned in the wing by drilling through the balsa wood, plywood, and foam. The positioning of holes in the fuselage bulkhead for engagement of the dowels is done as follows: cut dowels oversize — in length — by approximately $\frac{1}{2}$ inch, trim and sand points on one end of each dowel (easily done with a pencil sharpener), temporarily install the dowels in the wing with the points protruding from the leading edge approximately $\frac{1}{4}$ inch. Now rub some dark wax from a common crayon on the dowel points and place the wing into the position you wish it to be for final assembly. If care is taken, the crayon tipped dowels will leave marks that should be the exact center of the holes that will be needed in the plywood bulkhead.

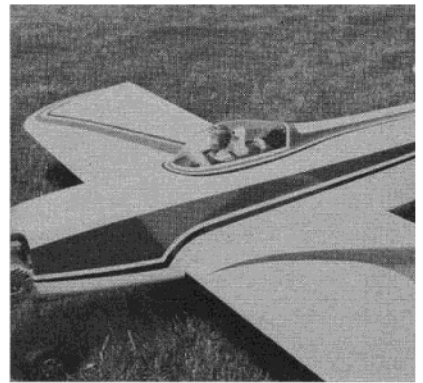
Installation of the Cam-Locks is accomplished by first gluing the plywood Cam-Lock pin and sleeve holders to the underside of the wing and drilling holes in the location specified on the plans. When the Cam-Lock pin and sleeve are in place in the wing, complete the unit assembly by pressing on the bracket

portion of the Cam-Lock assembly. You now have the Cam-Locks all assembled but dangling in the wing. Place the plywood bulkhead doubler into position behind the Cam-Lock brackets and mark, with a pencil, where bolt holes will have to be made to hold the brackets to the plywood doubler. With the brackets bolted to the doubler, re-assemble the Cam-Lock units. You should now have the entire Cam-Lock assembly and plywood doubler hanging in place. By making some basic measurements, you should be able to preposition the plywood doubler on the permanent fuselage bulkhead. Temporarily install the doubler with two small wood screws.

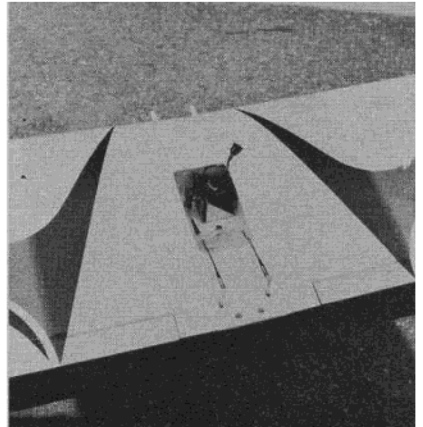
Assuming that you have the two wing dowels in position and inserted in their respective holes in the forward bulkhead, carefully press the Cam-Lock area down into position in anticipation of hooking up the Cam-Lock units. A note of caution. You may need minor reshaping of the receiving dowel holes to permit seating the wing in its final resting position. Another factor to keep in mind is the thickness of the gasket material used between the fuselage and wing. Material such as "Fu-Seal" compresses to approximately $\frac{1}{16}$ inch, but should not be overlooked when trimming the dowel holes. The permanent installation of the doubler bulkhead is made with four wood screws. This will be more than adequate and will allow you a shear point in case of a holocaust.

During my many years of model building, I have developed a weakness for a particular area on a model airplane. Let me explain this statement by saying, "Filletts" and "Concave Surfaces." I believe that any model builder worth his weight in balsa wood should be able to make a presentable fillet between two adjoining surfaces; for example: The vertical and horizontal stabilizers. Without a lot of fanfare or "Playboy Philosophy," I will give you my approach to the perfect fillet, and one which is not affected by dope shrinkage. Dart III has a fillet that goes around the canopy and runs the full length of the dorsal fin before it blends into the vertical and horizontal stabilizer surfaces. Without exception, every model builder that has looked at the Dart and has run his finger along those three foot fillets says the same thing: "How do you do it?" My reply is always very enlightening: "It's easy!" The specifics follow. Buy a $\frac{1}{2}$ pint-size can of epoxy auto body filler. Get the variety with a metallic base. Your first impression of the material as you lift the can from the shelf is that the guy who told you to get this stuff must be a nut. The weight of that small can feels like 50 pounds.

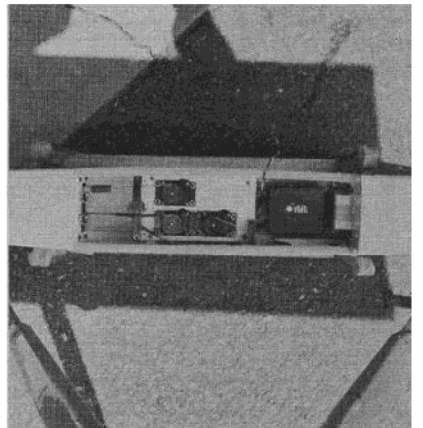
In application, the total weight of epoxy filler used on the Dart is about $\frac{1}{2}$ oz. It will give a lighter and stronger surface than any dope and balsa filler



Dart III and friend.



Aileron servo installation.



Orbit propo installation.



Capt. Winter and Dart III.

combination. Mixing the epoxy filler is nothing more than adding a few drops of the catalyst that usually comes in a little tube with the can of filler. You can increase or decrease the pot life by varying the amount of catalyst. Normal working time with the filler is approximately 5 to 10 minutes before it sets and hardens. The method I use for making a fillet is to first build up the desired area with balsa wood to the general size and shape of the final product. All you do now is wipe the epoxy filler on with your finger in such a manner that your finger assumes the radius of the fillet. You do not have to prepare the balsa wood with dope or anything else before applying the epoxy filler. Try to keep the thickness of the filler at about $\frac{1}{16}$ inch. This is not extremely important so if it is thicker or bumpy in spots, don't worry, you will sand this all down to the desired thickness and shape later. I recommend that on the Dart you spread a layer of

it once and you will see unlimited possibilities for this material in model building. To aid in sanding the epoxy filler to a desired radius, I have cut small two-inch lengths of different size dowels to be used as sanding blocks. On small radii such as around the canopy, I use small rat-tail files. The preparation of the fuselage with dope, silk, and filler can now be started.

Be sure that the epoxy-filled areas are sanded so they blend smoothly into the balsa areas. Use light pressures when accomplishing this step because the epoxy filler is harder than the adjoining balsa. Before applying the first coat of clear dope on the fuselage, I have every crack and dent filled with a balsa filler and sanded smooth. To ensure that the canopy does not get dope on it, I have it covered with masking tape up to where the epoxy filler starts.

Now, put on your first coat of dope. Let this dry for about one hour, then

paint finish. If you use, as a guide, a maximum of two coats of clear or pigmented dope and a minimum of six hours drying time, you will be rewarded with a finish that will retain its shine and smoothness for years. I have rushed paint jobs only to do the job over a month or two later. The shine and smoothness fall victim to the slow drying and shrinking of the bottom layers of fillers and dope. I have never had to use rubbing compound on any of my aircraft to get a smooth, glossy finish. It is accomplished by allowing paint to dry thoroughly and, with a light touch, wet sanding with 400 paper before each spray application of paint. The final gloss is achieved by two coats of clear dope.

The method I use to achieve sharp lines on my trim is the old reliable technique of applying two coats of clear dope on the edge of the masking tape that makes up the edge of the trim. Al-



epoxy filler over the entire dorsal fin and have it extend over the upper fuselage block.

The canopy must be permanently glued in place so the dorsal fin fillet will blend in with the canopy fillet. This necessitates the installation of the pilot, instrument panel, headrest, and loop antenna in the final painted condition. Masking tape is put around the canopy about $\frac{1}{8}$ inch up from all edges. The tape will be removed after the epoxy filler is filed and sanded to give the desired fillet radius. The epoxy filler on the canopy is trimmed down to the thickness of the masking tape to allow removal of the tape without breaking or lifting the installed filler material. Blending-in the horizontal and vertical stabilizers with the dorsal fin is accomplished in a similar manner by wiping on the epoxy with your finger.

Filing and sanding epoxy filler is very easy and makes for enjoyable work. Use

apply the second coat. Let this combination dry for at least six hours. The theory I work under to get a good paint finish on my airplanes is to completely fill all balsa wood surfaces so they are no longer porous before applying the silk covering. I use Sig Super Fill thinned down so it flows on easily. Each coat is allowed to dry thoroughly before it is dry-sanded with 320 wet/dry paper. Two or three coats should do the job. The entire fuselage should be smooth and without a blemish prior to silking.

The silk is applied wet and in a manner to give you the least amount of overlapped seams. Do not silk over the dorsal fin. As a guide, do not apply silk to any concave surface; these areas should be the ones with epoxy filler. Clear dope is applied over the silk while still wet. Two coats of clear dope should be adequate before the thinned-down Super Fill is applied. Patience is a prerequisite when one wants a professional

low the clear dope one hour drying time before applying the color. Apply as many coats as needed to give a deep rich color. Allow the paint to dry for at least one hour. If you wait too long, i.e. overnight, you could have trouble removing the tape and getting that desired sharp edge. Remove the tape by pulling it off level over the tape that is still in place. The two coats of clear dope, that I mentioned in a previous paragraph for final gloss, can now be applied over the entire airplane.

In conclusion I would like to say that the Dart III is a full-fledged stunt aircraft. The power plant presently being used is a Super Tigre 60 which will make the Dart fly straight up. I am using an 11 ounce fuel tank, more than adequate for the full AMA stunt pattern. Initially, aileron and elevator throw should be kept to a minimum.