

CONSTRUCTION

by FLOYD MANLY

WHY A basic canard? The answer is simple! Because a backward-flying airplane is fascinating, particularly from an airshow standpoint.

The design of the Basic Canard came to me one day when my 4-year-old grandson, Derek, needed a babysitter. Since I was volunteered, I needed something to entertain a very energetic and highly intelligent little rascal. We got a dime-store

balsa glider and used up 10 or 15 minutes putting it together, balancing it, and attempting to explain why it flies. The next 30 to 45 minutes we tried to wear

off some of his energy by chucking it all over the backyard. Then for some reason Derek tried throwing the glider *tail first*. Naturally it didn't fly worth a darn and he wanted to know why! "Why? Because it's not designed to fly backward, but maybe we can fix it so it will." We moved the clip-on weight to about $\frac{1}{3}$ of the way behind the wing and tried it. It flew, but with a yaw that fell into a flat spin (try and explain "yaw" to a 4-year-old), so we pulled the vertical fin off and glued two new ones out on the tip of each wing. It flew beautifully!

When Derek's mother came to pick him up, he fascinated her with the "backward" airplane that he and Gramps had



BASIC CANARD

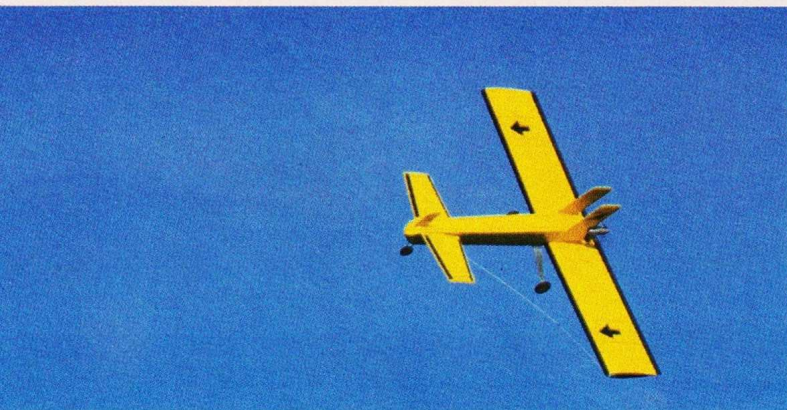
A perfect subject to launch you into the canard revolution.

"zigned." Her casual question of whether I was going to make an R/C model of it was answered after only a moment's pause, "Sure, why not!" This led to the B.C.

I think now it would have been easier to have put the motor up front, but for some reason I first drew it in as a pusher, so that's what it remained. The only rationale I had was that if the wing was on backward, the motor should be backward also. I built positive incidence into the canard surface because the backward glider had it. I set the wing incidence at 0 degrees, figuring that it would stop flying before the canard. I estimated the size of the wing fins to be approximately the same as ones I would have put on the tail, and approximated the CG as the same as the glider. I set the motor at 1 degree up (prop down to the rear), thinking that since the center of thrust was higher than the center of mass, it would tend to hold the nose down under power. How wrong I was!

The last assumption I made in the design was that a small rudder would be more effective on the nose than two would be out on the vertical fins. It would be a lot easier to build and it would put the weight where I needed it. Because this was to be a test-bed aircraft, I just stuck it on top of the extended nose wheel strut. It looked goofy up there and would it work? Would anything I had assumed work? Would it fly?

Well, you're reading this article and you can see the accompanying plans, so you know that it did work. Read on to



SPECIFICATIONS

Type: Sport

Span: 60 inches

Area: 710 square inches

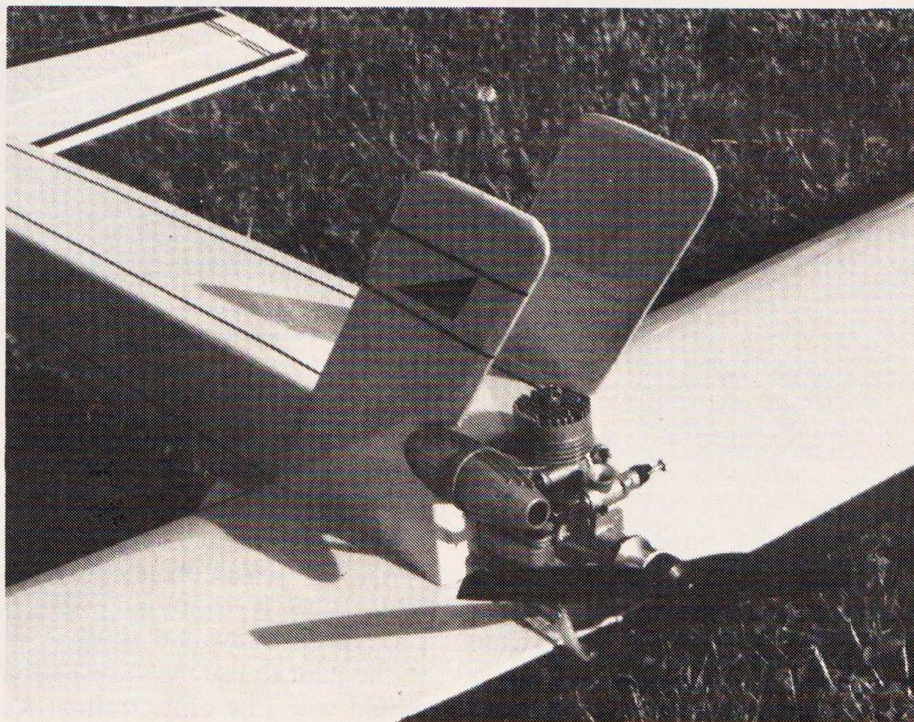
Weight: 4 pounds

Channels: 4

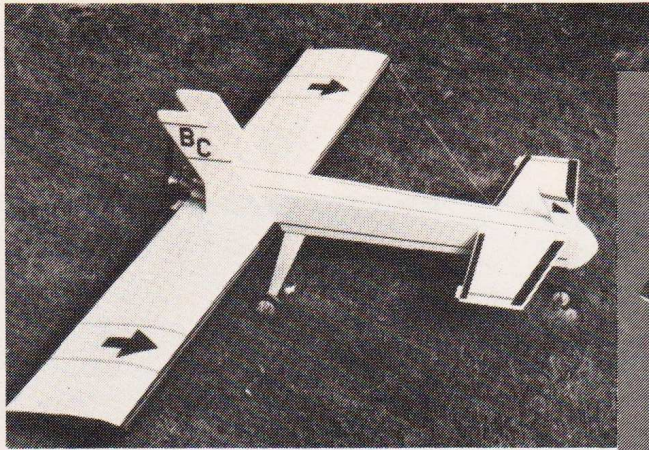
Engine: .40

the final flights and you'll be only two weeks away from flying your own Basic Canard.

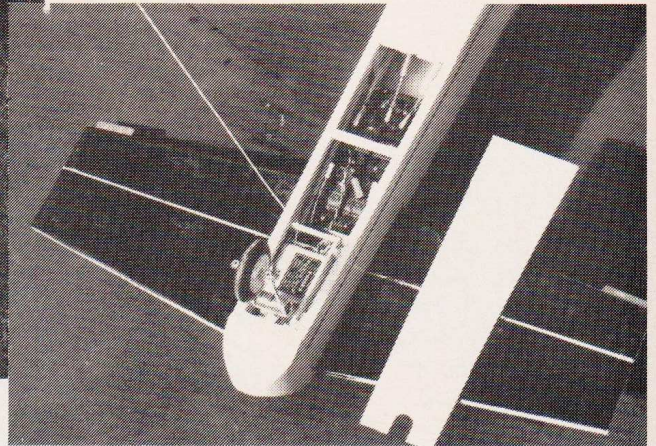
Why am I suggesting a canard as a basic trainer? Because, in spite of what people on the bus say, they're stable, easy to fly, and more forgiving of all a beginner's mistakes than any design currently available. Why then aren't all basic trainers canards? Because they're different, as different as front-wheel cars were 10 years ago. In a very short time, as



This is the rear end of the airplane. Note Master Airscrew pusher prop.



Arrows point in the direction the BC is supposed to fly, just to remind the forgetful. Right: Forward installation.



manufacturers rediscover the canard, you'll start seeing more and more new models at the field.

If from no other viewpoint than the cost factor of learning to fly R/C, a canard as a trainer makes sense. Broken props are almost non-existent and broken engines never happen. The cost of a canard is no more than a standard model and there isn't any exotic equipment that makes them different, just the arrangement of the parts. It's entirely possible to take, say, an Ugly Stik, and turn it into a canard with just the parts in the box. This is almost what I did with the BC. I made no attempts to develop anything but a very basic trainer: no frills, no fancy shape, no criteria, except to make it fly. Well, fly it does and beautifully too, exceeding my expectations.

I questioned the use of a symmetrical wing, but by using the TLAR theory of design aiming at a mid-range performance aircraft, I was pleasantly surprised by the low-speed stability I stumbled on. The BC handles so well at all speeds that I haven't considered a flat bottom wing any further.

I want to caution beginners that a .40

will haul the BC around faster than any other trainer, and she'll be out of sight or shape in two blinks. I strongly advise a .25 for power to begin with. If you must use a .40, a 9x6 or 9x5 prop would be plenty. Unfortunately, to my knowledge pusher props are only available in 10x6, so it's up to the pilot to use the same discretion he would with any other trainer. Keep the power down!

CONSTRUCTION. Mike, my cohort and strictest critic, helped me with this project and we tried to keep the BC as simple as possible. The plans show where to glass, brace or gusset, and if you study them you'll have no trouble. The following hints and sequences will make assembly go much more smoothly.

For the wing, cut all ribs and mark their tops with a felt-tip pen. They're supposed to be symmetrical, but home-cut ribs don't always end up exactly that way.

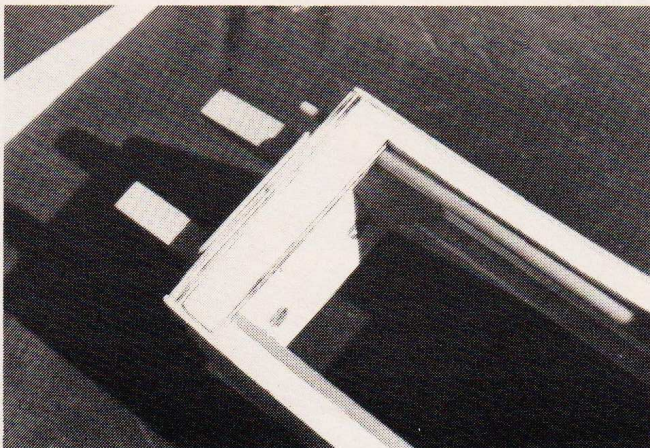
Build the left wing over the plans, then build the right panel over the same layout

by putting the pen marks *down*. Finish the wing by joining the halves, glassing the center section, and adding the ailerons. Hold off installing the dowel and drilling the bolt hole until you have the fuselage ready.

When you have the fuselage complete to the point of sheeting its bottom, place the wing in the saddle and check its alignments of incidence and skew. Hold it firmly in place, then drill through the hole in former F-2 into the wing leading edge. Epoxy the leading edge dowel, check for alignment again, then drill the hole for the nylon wing bolt through the center rib and into the ply mounting plate.

For the fuselage, cut the side sheeting, then add the long stringers, wing saddle, and vertical and diagonal stringers to each side.

Align the sides over the plans and glue formers F-2 and F-3 in place. Epoxy former F-3 after checking the thrust alignment, but don't add the wing bolt



Left: Beefed bulkhead with gussets. Above: All-flying rudder seems to be in the wrong place but isn't.

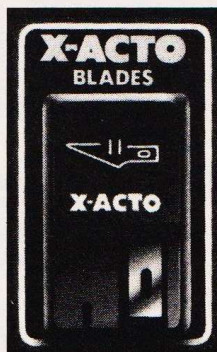
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BASIC CANARD

plate until after you've drilled for and installed your motor mount blind nuts.

Install the top sheeting over the tank compartment now, to prevent the sides from bowing when you pull the nose together, but first epoxy the landing gear plate and its gussets to F-2.

Now pull the nose together, glue F-1 and the ply gussets in place and add the horizontal cross members, top and bottom.

BASIC CANARD

The fuselage is now ready and you can finish the wing installation. The bottom of the fuselage is a 0 degree datum line, so use it to check the incidence of the wing. If you make an extra rib with cap strips, you'll find it very handy to mark and sand the saddles to exact shape.

Glue on the top sheeting but hold off on the bottom sheeting until your servos are in. You'll need this access to align and brace the aileron and throttle control rods, and epoxy the landing gear blind nuts.

Cut, fit, and align the horizontal stab to its saddle, then set it aside until after you've installed the nose wheel with its arm and linkage to the servo. Take note that the plans show the nose gear is installed to give the stab 0 incidence during taxiing and takeoff.

It will be much easier on your nerves if you cover the stab, elevators, and fuselage before epoxying the stab in place.

When fitting the receiver and battery into the compartments, wrap them with at least 1/4 inch of foam. Most importantly, assure yourself that they cannot shift to jam the elevator or rudder arms. Glue in hard balsa braces as needed, so as to be positive.

At this point there shouldn't be any other sequence problems and in fact you should be almost ready to fly.

FLYING. The plans you see here are the result of much testing and test-flying. First flights were not always smooth, but they did teach us a lot. On the first flight, she flew beautifully for about three minutes until we tried a loop. Going over the top she rolled out like she was doing an intentional Immelmann, and continued into a flat spin. With the nose down about 30 degrees, she came all the way into a soft, freshly plowed field. The

sticks seemed to have no effect.

This happened three times. The takeoff would be smooth and, as long as we kept the speed up, we could groove her all over the sky. If we let her slow down, however, then try to turn her any way, she'd roll over into a slow flat spin. There was minor damage each time, but no broken props.

Cohort Mike said, "Back to the drawing board." I thought we needed more lateral area. We deduced that the tip fins were working during fast forward flight, but were too parallel to the perimeter of rotation during a spin. They would knife their edge instead of presenting a flat surface. We added a fin to the fuselage just forward of the motor.

We also evaluated the forward rudder and pondered the change of pitch attitude caused by throttle changes. The BC would pitch up when the power was cut. We trimmed for 1/2 power and she would nose down when more throttle was added, but not while idling. This indicated that an adjustment to prop angle was needed. Use of the forward rudder resulted in a yaw, with very slight roll and a pitch-down in spite of the 2-inch dihedral of the wings.

One definite conclusion was that the .40 we were using had much more power than we needed. The BC will probably fly nicely with a hot .20 or .25.

On the next flight it grooved with not a hint of instability. The quirk of rolling out at the top of a loop was gone. The BC tracked like it was on rails! We tried everything we could think of to get her to tumble, but she wouldn't fall off. By George, we got it!

Next we cut the tip plates down by half, and she was still beautiful. We cut more off the plates and saw no change. Then we added 8 ounces of lead to the nose to keep

her from zooming when the power was cut. Too much! We took 2 ounces off again.

Next we tried to get her to break. Inverted flights were perfect. We did outside loops and knife-edge circles. She needed more rudder. Next we tested for slow flight. With the motor at idle, we pulled and held full up. She'd swoop, drop her nose and start flying again, with each swoop getting smaller until she settled into about a 45-degree descent with the nose high. I was so enthralled with her helicopter-like approach that I settled her into the weeds.

Next we cut the tip plates completely off. They looked good, but seemed to be ineffective and the wing was simpler to build without them. For the first few seconds we thought we had hit the jinx. The BC jumped off and wanted to loop back over the parking lot. We managed to roller-coaster up to where the trim could be clicked down. We had changed the motor angle to see if we could whip the pitch-down tendency when power was added from idle.

We had talked to Jim Schmidt of St. Croix Models, designer of the .40-size Rutan Long E-Z, and he confirmed our suspicions. His Long E-Z needs 2 to 3 degrees of down-thrust (with the motor tilted *forward*). This change solved all but a very slight pitching. A side bonus was that we could remove 6 ounces of lead from the nose. With a lesser motor than our Fox .40, it probably wouldn't be noticed.

The final version of the BC—and what you see in the plans—has all the bugs worked out. It flies better than our test version. You'll notice that we've mounted the aileron servo in the tray with its buddies. We could then drop off all of the

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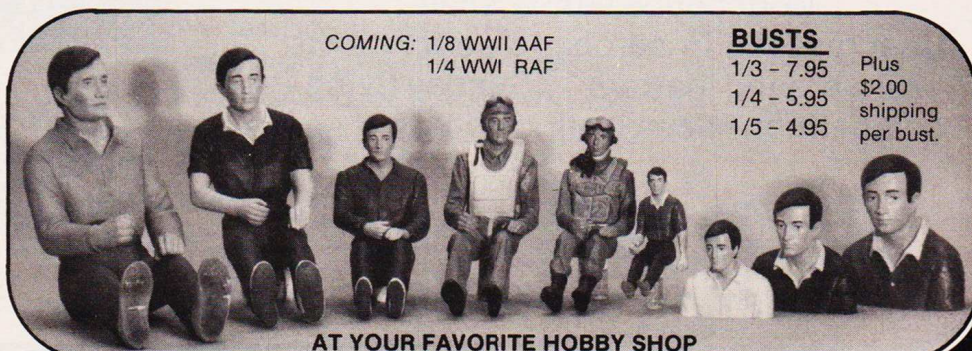
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BASIC CANARD

nose ballast. The motor is as low as possible, and the fuel tank is mounted nozzle forward.

After 30 test flights and many changes, the flight characteristics are amazing. Fast rolls are clean and crisp. Inverted flight is easier than right side up. Stall flight is easier than right side up. Stall fall-offs are non-existent, even when holding full up elevator. All she'll do is roller-coaster for a while and settle in a nose high descent. Stall turns do require being executed earlier, but other than that she's as gentle as any conventional basic trainer. So much so, that we considered calling her the "BTC" for Basic Training Canard, but we thought BC had a nice friendly ring to it.

What is the TLAR theory of design? It's simply a method of drawing lines on a paper napkin in the shape of an airplane until you can say, "That looks about right."

The BC not only looks right, it came out right. We designed a flyable aircraft instead of a crash-proof one, and finished up at 4 pounds, 6 ounces. Hang that on 713 square inches of the flying surfaces of the wing and canard, and you're almost in the glider range of wing loading. She'll float in a breeze and is as gentle as your old tom cat.

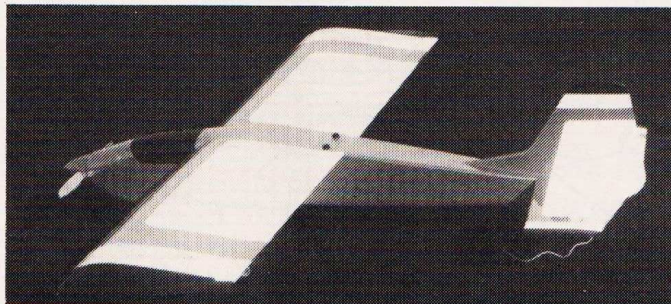
There's just no reason for you not to build and fly your first canard. We've solved all your problems with the BC! ■

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