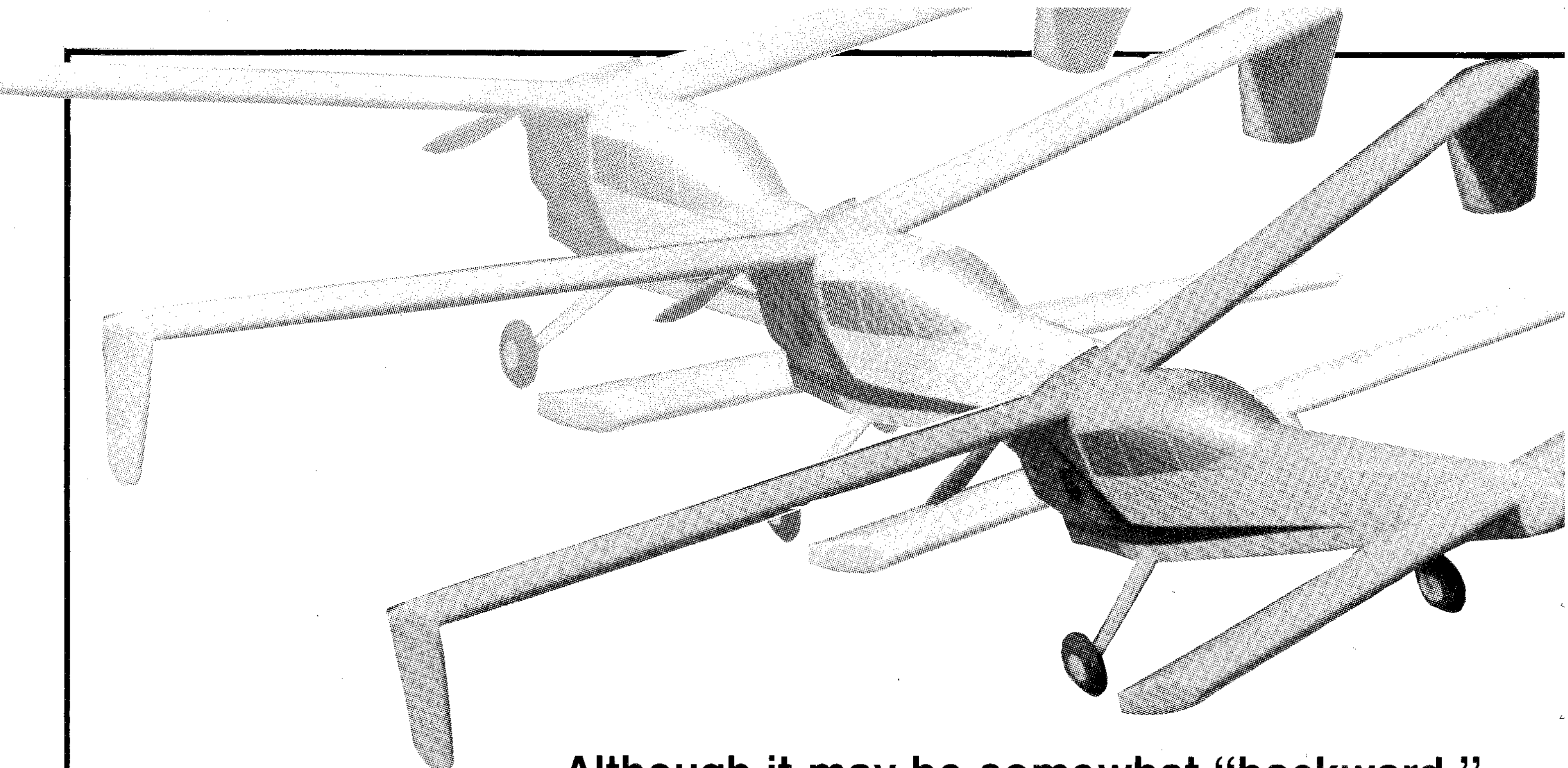


Although it may be somewhat "backward," our feature aircraft shows some "forward" thinking. Something a bit different for your amazement and amusement!

by A.G. LENNON

CANADA GOOSE

CANADA GOOSE
TYPE: Sport—Canard
WINGSPAN: 51 inches
WING AREA: 444 square inches (forward wing, 101; main wing, 343)
LENGTH: 34 inches
WEIGHT: 75 ounces
WING LOADING: 24.3 oz/sq ft
PROPELLER: 10x5 or 10x6 pusher prop
ENGINE: .30-.35
RADIO: 4-channel

• Modern R/C equipment can provide miniature aircraft with all the flying capabilities of their big brothers. It is now possible to design, build and fly small prototypes of your "dream ship" that are limited only by your imagination. The flying field becomes both a wind tunnel and a flight test area; while crashes do occur, no lives are lost. This canard-pusher, or "tandem wing biplane," is an example of just such a miniature aircraft.

The basic configuration of this model was conceived in 1972. During the following year seven balsa gliders of about 18″ span were designed and built to explore the characteristics of canards. The best features were selected and combined into one design, and detail drawings were prepared; the Canada Goose first flew in 1974.

Several crashes later and after considerable rebuilding, it became evident that there was serious longitudinal instability when the model performed even a gentle zoom. In level flight, gliding or climbing, it performed well. A mild zoom, following a flare during a landing approach, resulted in an uncontrollable, shallow dive toward the runway—bad for both the model and the designer's ego. At that point my fellow Montreal R/C Club members were heard to mutter words such as "Ruptured Duck."

I was discouraged and frustrated, but persistence finally paid off and the problem was solved. The original forward wing section (NACA 2415) arrived at "zero lift" angle of attack as the nose dropped in a shallow dive. The main wing section, however, continued to lift, causing this dangerous characteristic. While pitch control could bring the model to level flight, some 25 feet of altitude was lost, and just wasn't there on the landing approach.

The forward wing was redesigned, using the same section as the main wing (NACA 4415). Its area was reduced both because of the higher lift coefficient of this section and because it was set at 3½° angle of incidence versus the former 3°.

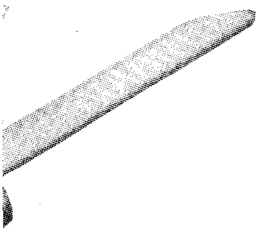
Further flight testing proved that the longitudinal instability was at last corrected. The model exhibited no undesirable characteristics, and flew very well indeed.

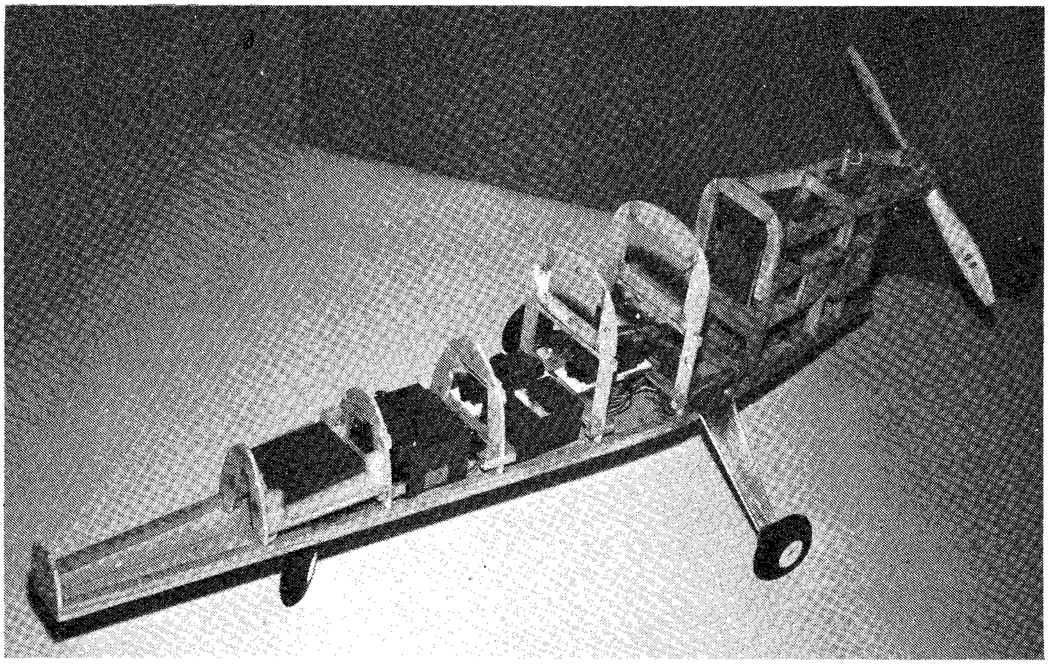
In 1976 a pilot error (mine) resulted in a 180° roll 10 feet above the ground, followed by a crash that required a new fuselage and forward wing to undo.

Subsequent flights indicated a mild dutch roll at high angles of attack and slow speed on the landing approach. Two factors were responsible. There was too much dihedral on both the main wing (7°) and forward wing (6°); this has been corrected in the drawings. Also, the two wing dihedrals were not aligned—the forward wing, when viewed from the front, was slightly out of skew with the rear wing. The dihedrals were, in effect, fighting one another; hence the mild dutch roll. The Goose is still in one piece and last flew in 1978.

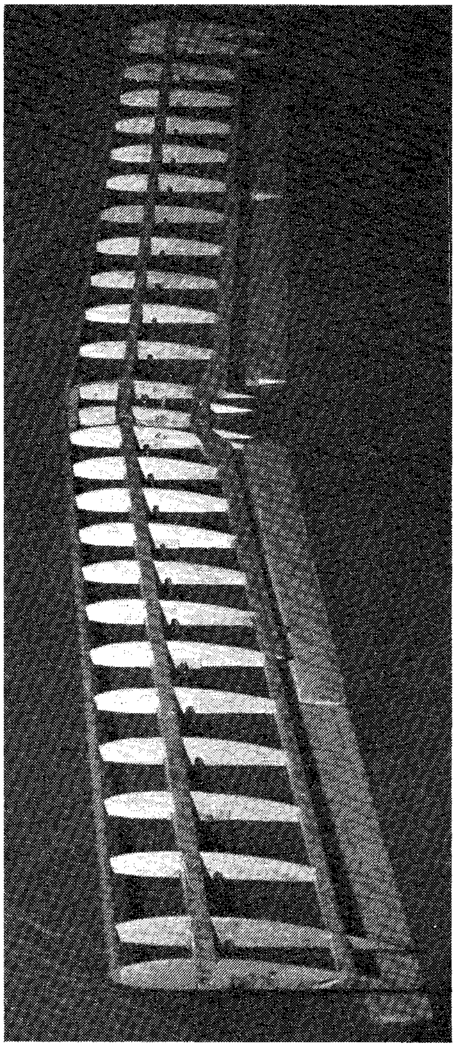
During all this test flying, the model was plagued by frequent in-flight, inverted-engine quits at low rpm, leading to forced and sometimes damaging landings. This was overcome by the on-board battery installation; using tank pressurization via a muffler tap was a further improvement.

DESIGN. The canard configuration has major advantages. The forward wing at higher angle of attack than the main wing will stall first, and thus prevent the main wing from stalling. Stall spins, a major





A 3/16" balsa fuselage floor and a couple of 1/4" stringers form the foundation and automatically jig the construction.



Wing structure is simple and constructed on a drill rod alignment jig.

cause of fatal lightplane crashes, are extremely unlikely. Also, both wings contribute to overall lift.

This configuration has two disadvantages, though. One is aerodynamic, in that the main wing cannot achieve its maximum lift capability and therefore its slowest landing speed. The other is structural; relatively heavy piston engines used in both model and full-scale lightplanes, in the pusher position, make it difficult to locate the center of gravity far enough forward for good pitch and yaw stability. (Small, full-scale canards, such as Rutan's "Varieze," use the pilot's weight as "ballast.")

The canard pusher configuration is made practical for larger aircraft by the light but powerful turboprop or jet engines now available. One such 6-place canard pusher, the OMAC-1, powered by a 700 SHP Avco Lycoming engine, was flight tested in early 1980. (A scale project on the OMAC-1 was flown by Col. Bob Thacker at the 1980 AMA Nats!) This aircraft bears a distinct resemblance to the Canada Goose, but has unswept fins and rudders at the wing tips rather than the downward version, both of which act like Hoerner wing tips in controlling wing tip vortices.

In keeping with the "scale prototype" concept and because of a relatively high wing loading, flaps were incorporated in the design.

Since a canard obtains lift from both front and main wings (in contrast to conventional designs, which have the main wing lifting and the tailplane normally bearing a download to compensate for the CG ahead of the main wing center of lift), both wings have to be "flapped" or some provision made to increase lift from the forward wing if it is not equipped with flaps.

In 1972, during the design stage and after exploring available technical literature on canards from American, British, German and Japanese sources, I arrived at three variations that made sense. These were:

(1) Slotted flaps on front and main wings, regular ailerons and wing tip rudders. Front flaps serve as both flaps and elevators (flapevators?).

(2) Forward wing mounted on a pivot like a stabilator—the whole wing changing incidence for pitch control, whether main wing slotted flaps are deployed or not. Ailerons and rudders as in (1).

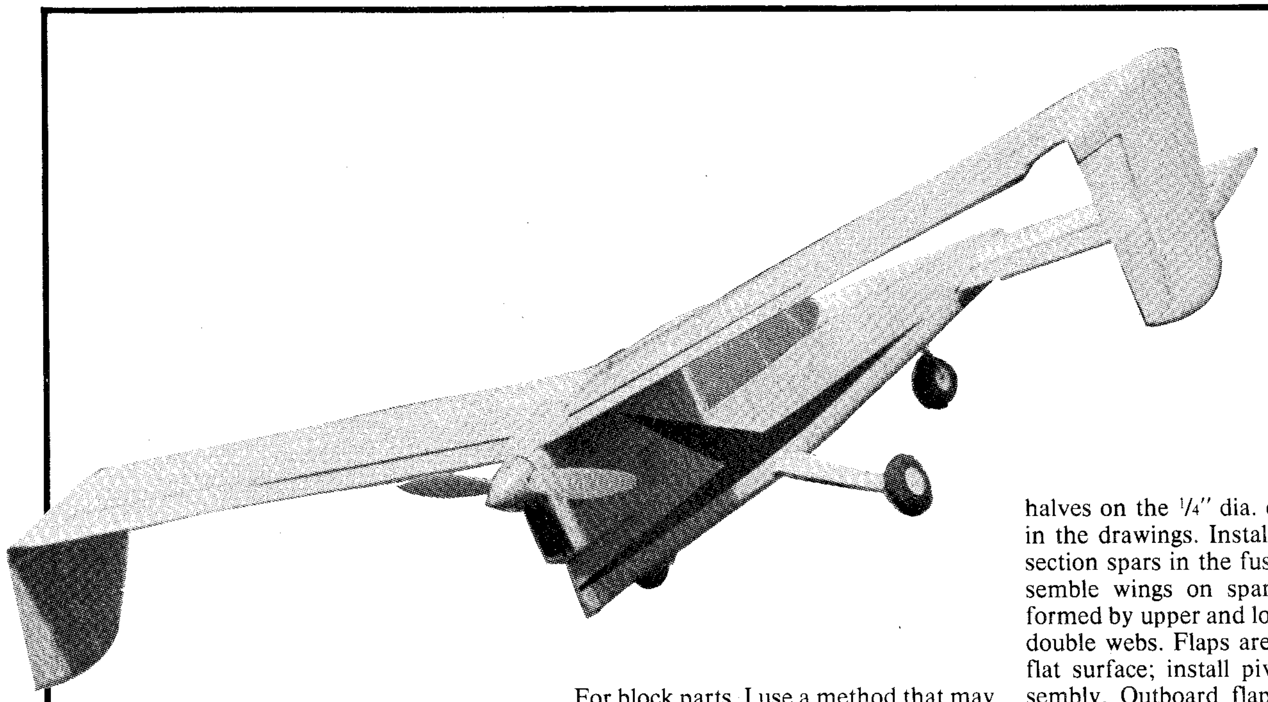
(3) Slotted flaps on both front and rear wings operating simultaneously but as flaps only. Ailerons act as "elevons" for both pitch and roll control.

After much consideration, and confirmed by the glider test flying, I selected mode (1).

The model utilizes one 180° servo for simultaneous operation of both sets of flaps. A simple linkage to an "elevator" servo permits overriding movement of the forward flaps, up or down, for pitch control regardless of the flap position.

Ailerons are conventional and differential. Rudders are downswept from wing tips and are also differential (i.e., rudder on the inside of the turn moves through a greater arc than that on the outside). For good aileron control at high angles of attack, the main wing leading edge has been drooped progressively from outboard of the flap to the tip, where it reflects a 1½° reduction in incidence.

To maintain the CG location shown, all the radio equipment and the nose wheel are mounted as far forward as possible.



Likewise, the motor should be as light in weight for displacement as possible—the O.S. Max engines qualify in this respect. Also, the "exhaust stack" type muffler should be as short as practical while still providing tank pressurization.

Accessibility of all radio equipment and of the motor is facilitated by the removable fuselage top forward of the wing and the lower cowling.

As mentioned earlier, on-board glowplug batteries (two 1½-volt size AA cells wired in parallel) provide a "hot" plug at all times and insure consistent operation of the inverted motor.

Construction is stressed skin—for smooth, true surfaces (no covering sag between ribs) and for a rugged structure. All control horns are internal, and external components (landing gear legs and wheels) are faired or "streamlined."

This is an aerodynamically clean model with a flat glide; but with flaps down, steep, slow approaches are possible for easy landing control.

CONSTRUCTION. The drawings of the Canada Goose have been arranged so that those parts dealing with components, such as ribs and bulkheads, can be cut out and duplicated on photocopying (such as Xerox) machines. Lightly cementing the copies to your balsa with rubber cement permits you to cut out the parts by cutting through both paper and balsa; the paper strips off easily. The same procedure can be followed for the plywood parts.

(Because of the thermoplastic nature of the image deposited in the Xerox process, it is possible to transfer parts outlines by ironing the image directly to the wood with a hot pressing iron. Try this—it really works. However, do not forget that the copying process usually enlarges the original image by as much as 1%, so you will of necessity need to trim parts a bit to fit the plan.—Editor)

For block parts, I use a method that may or may not be original, but it certainly saves time and produces accurate parts.

Take the wing tips, for example. These have two straight edges, at right angles to one another, one along the last wing rib and the other along the upper fin rib. Take your copy of the top view and rubber cement it to a rectangular cross-sectioned balsa block that is a little larger than the wing tip. Then take the side view and cement it to the surface at right angles to the first. Line up the straight edges of the drawings with the edges of the block and make sure that the drawings both start at the same point on the block. Using a Dremel or band saw, cut one curved surface following the drawing outline. Pin the piece that was cut off back on the main block—carefully (ordinary pins will do). Then make the second cut on the second drawing. The result is a wing tip with two of its three dimensions exactly to drawing; after a little carving and sanding, it's finished. When making the opposite, be sure to make it the opposite "hand"—right or left as required; it's embarrassing to end up with two right-hand wing tips.

Fuselage. Those bulkheads in balsa are composed of several parts that can be cut out and then cemented together over the drawing, pinned in place. This insures accurate assembly.

Since the 3/16″ balsa fuselage bottom is flat and straight, it can be used as a building jig, but first install the 1/4″ sq balsa strips lengthwise on the outer edges of the bottom. Install bulkheads and formers, plywood landing gear pads, landing gear legs, basswood wing and motor rails, and cowling duct inner and outer walls before sheeting. The motor cooling duct may be difficult to visualize, but study of the drawings and the fuselage photo will clarify its construction. Pay attention to balsa grain direction shown on the drawings when "skinning" the fuselage.

Forward wing. Assemble this in two halves on the 1/4″ dia. drill rods suggested in the drawings. Install hardwood center-section spars in the fuselage nose, and assemble wings on spars using the boxes formed by upper and lower wing spars and double webs. Flaps are assembled on any flat surface; install pivot pins during assembly. Outboard flap bearings are 1/16″ i.d. Epoxy grommets or brass tubing in the plywood end plates, which should be installed last after surfaces have been covered.

Main wing. This is similarly built in two halves on the drill rod alignment jig—but do not apply the balsa skin to the upper surfaces. Build a flat jig for assembly of the two wing halves, at the proper dihedral angle of 3° on each side, from any material you may have around (plywood, insulating board, etc.). Make sure that the 5° sweepback is correct. Install the center-section rib, the plywood and balsa block center-section reinforcements, and the two dowels. Assemble the brass torque tubes, bearings, collars and horns, and drop them in position in the slots in the rib tops provided for this purpose. Epoxy the plywood bearing supports to the appropriate ribs. Install wing tips and fins before you sheet the top surface, making sure that all pushrods for flaps, rudders and ailerons are installed. Add the top front and rear fairings, and smooth the joints with Sig Epoxolite. Don't overlook the plastic antenna tube. Flaps, ailerons, fins and rudders are assembled on a flat surface. Flaps are installed by springing the plywood flap supports gently outward only enough to permit the pivot pins to slip into the grommets.

Fins and rudders. Hinges are double MonoKote (as are aileron hinges—see drawings). Note also that rudders are hinged on the outside, i.e., right- and left-hand. Rudders are slipped on the 1/16″ wire pivots during this hinging and well epoxied with the wire. MonoKote hinges provide "sealed" control surfaces—no leakage to reduce control efficiency.

Receiver and servo installation. Install where shown on the drawings, arranging cross rails to suit your brand of equipment. The antenna is run down the fuselage and into the plastic tube in the wing.

(Continued on page 107)

CANADA GOOSE

(Continued from page 16)

Servo-to-control-horn connections. These are made of flexible Nyrod, two each for ailerons and rudders, and one each for flaps and motor control. Flap, aileron and rudder Nyrods run through a portion of bulkhead No. 7, which is attached to the wing leading edge; thus when the wing is lifted off its rails, after removal of the forward canopy, it may be tilted by flexing the Nyrods gently for access to horns. Front wing flapevators and nose wheel are operated by push-pull rods.

Engine tank and muffler. A 4 oz slant-front tank is installed on its side as shown. A 6 oz round tank will just fit (it's your choice, just remember the CG location). As previously mentioned, muffler pressure to the tank, plus on-board glowplug batteries, is essential. The external motor starting batteries are connected by use of a subminiature plug with the jack mounted in the rear fuselage. A subminiature switch is used for controlling the on-board batteries off and on. Tank filling is done via the tubing to the carburetor, with the plane inverted and cowling off. Use an in-line fuel filter and note the clip for connecting wiring to glowplug.

COVERING. MonoKote was used, with silver or black to simulate windshield and side windows, but you can use your favorite covering. Cover all components before installation of flaps, ailerons, rudders, etc.

FLYING. Save time and your nerves—start the motor with the model upside down (motor upright) and the cowling off. Prime the engine and replace the cowl. When the motor has started, remove the external plug and switch on the on-board batteries.

You may wish to install a microswitch on the motor servo to disconnect the on-board glowplug batteries at high rpm. It's your option.

Before leaving home, make sure of the CG location. It must not be behind the position shown. Add lead inside the nose block if needed. Be sure that all controls operate in the proper directions. Note the many clevis holes in the control horns for adjustment of trim and control surface throw to suit your brand of flying.

This is a fun model, intended as a miniature prototype of a full-scale lightplane. I'd appreciate your comments on this model—just write to me in care of *M.A.N.* ■