VARIEZE

Frank Baker's trial and errors have resulted in this eye catching Stand-Off Scale version of Burt Rutan's popular home-built canard.

One of the most spectacular airplanes to appear on the homebuilt scene has been Burt Rutan's Varieze. The aircraft is unusual for both its composite structure (fiberglass over foam) and its canard planform. In addition, the Varieze has unusually high performance relative to its modest power. Since I live close to Oshkosh, Wisconsin, where the E.A.A. annual convention is held, I have been able to inspect the plane and watch it fly. It is every bit as spectacular in the air as it is on the ground. Last year there were four or five Varieze's at Oshkosh and the workmanship on all of them matched the usual pattern R/C model. Also a forthcoming space epic movie will use a small fleet of the Varieze as space style fighter aircraft.

When the Varieze first appeared, I looked at it from the point of view of an R/C model but decided that there were too many unknowns. About a year later, I read an article in the E.A.A. magazine *Sport Aviation* mentioning that Mr. Rutan had been an R/C modeler for many years. Being rather quick to recognize a truth, I decided that he had probably built and flown a lot of canard R/C models. Armed with this knowledge, I proceeded to build a quick approximation to a Varieze. True to the original Varieze, I put a Vector Director on the front canard to give both ailerons and elevators via the canard surfaces. When launched, this model would initiate a slight bank and never recover from the turn. I promptly shelved the model.

The next flying season, I noticed that Mr. Rutan had added ailerons to the main wings and turned the canard surfaces into elevators, so I did likewise. On the next test flight, I launched from the top of a hill. The plane went out straight as an arrow. Application of ailerons yielded the fastest roll I had ever seen. However, it still wouldn't turn and once the nose dipped below the horizon, there was no recovery. Knowing that I was making progress, I re-read the articles on the Varieze and noticed that the wing tip rudders only moved outboard to create drag for turning purposes. I also decided my canard was too small and increased its area by a third. The next test flight took me by surprise --- the plane flew perfectly! It would turn right and left, loop, would not stall, still rolled like mad, and had a smooth stable glide. After a few flights, I decided to disable the "kick-out" rudders and fly a pylon race. On the first turn, I discovered again that, without the rudders, it wouldn't turn --- and scratch one model. Although the "Schoolyard Canard" (RCM, May 1978) would fly without these rudders, the present model will not, for reasons that escape my limited knowledge of things aeronautical. However, it does fly. Now that the concept had been proven, all that remained was to build a pretty, Stand-Off Scale version to replace the balsa box prototype. The resulting Stand-Off Scale version is the subject of this article.

VARIEZE
Designed By : Frank B. Baker

TYPE AIRCRAFT
Stand-Off Scale Canard
WINGSPAN
37 Inches
WING CHORD
6⅛ Inches
TOTAL WING AREA
221 Square Inches
WING LOCATION
Shoulder Wing
AIRFOIL
Semi-Symmetrical
WING PLANFORM
Swept and Tapered
DIHEDRAL, EACH TIP
1⅝ Inches
OVERALL FUSELAGE LENGTH
29 Inches
RADIO COMPARTMENT AREA
(L) 12" x (W) 2⅜" x (H) 2⅝"
CANARD SPAN
23 Inches
CANARD CHORD (incl. elev.)
4 Inches
CANARD AREA
78 Square Inches
CANARD AIRFOIL SECTION
Flat Bottom
CANARD LOCATION
Shoulder Position
VERTICAL FIN HEIGHT
6¾ Inches
VERTICAL FIN WIDTH (incl. rud.)
3½" Average
REC. ENGINE SIZE
.049-.051 Cu. In.
FUEL TANK SIZE
1 Ounce
LANDING GEAR
Tricycle
REC. NO. OF CHANNELS
2
CONTROL FUNCTIONS
Ail., Elev., & Kick-Out Rud.
BASIC MATERIALS USED IN CONSTRUCTION

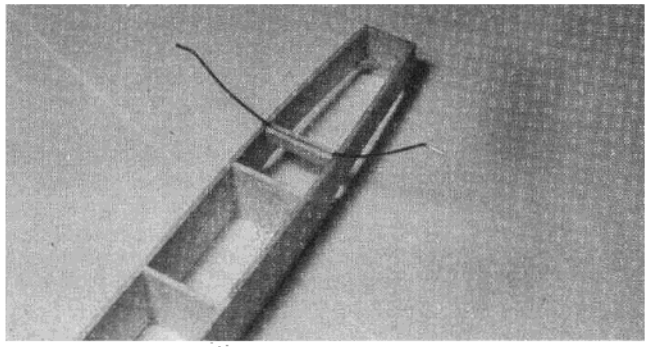
Fuselage	Foam, Ply & Balsa
Wing	Foam & Balsa (Ace wings)
Empennage	Balsa
Wt. Ready-To-Fly	28 Ounces
Wing Loading	18 Oz./Sq. Ft.

CONSTRUCTION

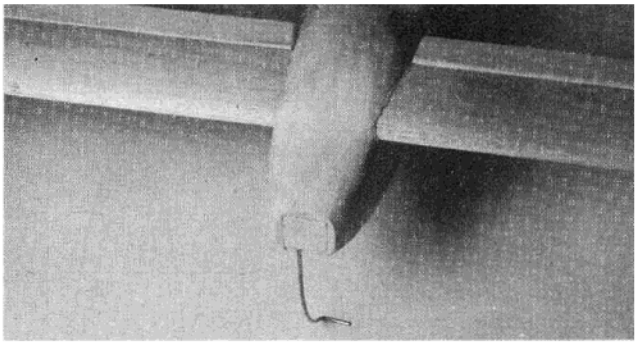
Due to the use of foam wings and rather simple framework, the construction of this model is straightforward. First, let me justify the rather sturdy fuselage. With the long span canard out in front, its tips tend to hit the ground if one makes a bad landing and they snag doorways. As a result, considerable stress is placed on the fuselage. My prototype fuselage of 3/32" sheet proved to be very fragile. The 3/16" sides on the present version are quite rugged and eliminated the breakage problem.

The fuselage is basically a box which is built upside down on the work bench as the top is flat. When installing the firewall, check to insure there are 2° built-in down thrust. Also, glue in the triangular plywood wing hold-down plates so they clear the fuel line holes and the motor mount bolt holes. You may need to do a bit of carving to insure the proper clearance. The main landing gear is 3/32" music wire held in a plywood sandwich. Install the landing gear before gluing on the 1/4" sheet that goes from the nose block to the firewall. Glue on the nose block and carve it to rough shape. It will be final shaped after the canard is mounted. The canard is built from one piece of hard 3/8" balsa sheet and the elevators are 1" trailing edge stock. I made the elevator horn out of 3/32" music wire and brazed a brass strip at the center. A Veco U/C elevator horn could be used; the important thing is that it be as long as shown on the plans to minimize the throw. Carve and sand the canard airfoil to a Clark Y with the rounded front about 1/8" above the bottom line. This provides the necessary front canard incidence. Mount the canard and use a level to insure the bottom surface is at 0°, also check to see that it is horizontal and perpendicular to the center line of the fuselage. Install the top balsa block and do the final shaping and sanding of it and the nose block. Use a razor saw to cut off the nose block where shown on the plans. Cut a 7/8" square 9/32" deep recess into the block. Make the nose gear out of 3/32" music wire and glue it into the 3/32" plywood sandwich. Glue this plate in the nose block recess and then glue on the tip of the nose block. A bit of final sanding will be needed. Now set the fuselage aside.

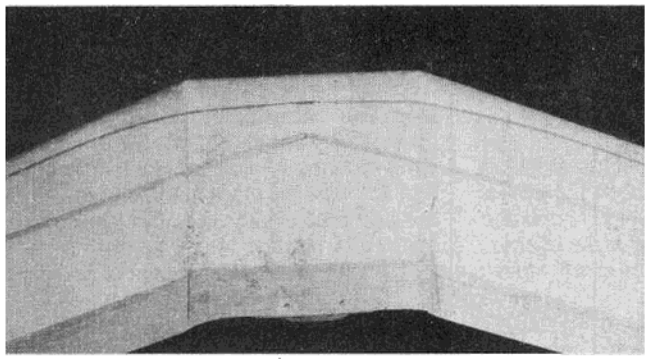
The wing is constructed of a 6" straight section of Ace 1/2A foam wing and two taper sections. Cut the taper sections as shown on the plans and place all three sections together on a table. Use a pencil to draw in the spar line on the top and bottom. Also be sure to check that the outboard ends are parallel to the center line of the wing. Cut



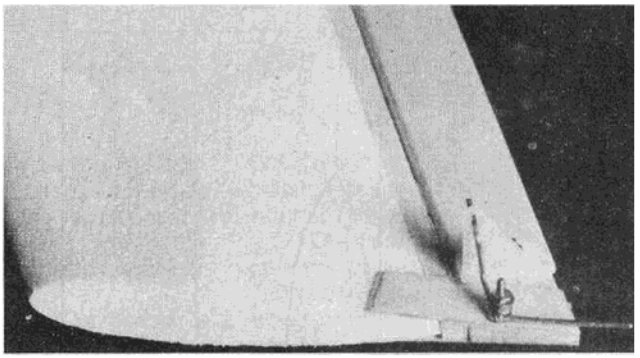
Landing gear sandwiched between two pieces of plywood.



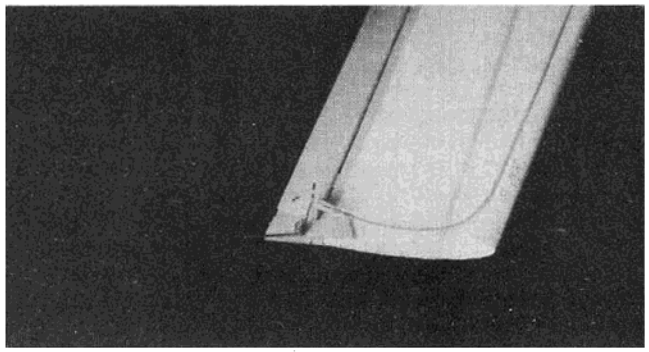
Nose blocks rough carved. Needs additional tip block and final filling and sanding.



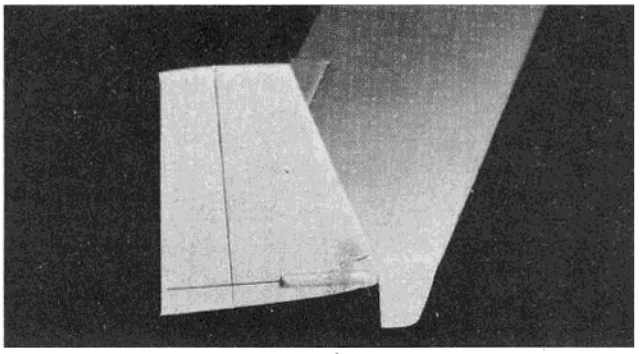
Six inch center section of Ace constant chord wing shows spar, trailing edge and Sullivan Gold'N-Rod and cable installed.



Aileron horn and rudder "kick-out" linkage. Linkage on both tips on bottom side.



Rudder "kick-out" linkage shown with aileron cable hooked up.



Rudder with .025" music wire to hold tension on rudder.

the grooves for the 1/8" square spruce spars on top and bottom. I used three brass gears in a mandrel and my Dremel saw power take-off cable. It will cut a smooth notch. Block up the tips of the outer wing panels 1⅝" and sand the inboard edge until it is perpendicular. Glue the 1/4" square trailing edge spar and then the 1" trailing edge stock to the center and two outer wing panels. Now use epoxy to glue the wing panels together. Before the glue sets, check the dihedral and the match of the panels to prevent twist. The 1/8" square spruce spars are glued in using white glue. Do not crack or cut them at the dihedral break; they will bend around these points easily. Now use two gears in your Dremel tool to cut the 1/16" slot for the aileron control cables. Install the ailerons and the 1/16" plywood reinforcing plate on the top and bottom of the wing tips. Build the rudders out of 1/8" sheet and install the return springs. These springs should be very light and have just enough pressure to return the rudder to neutral. Then glue the rudders onto the ends of the wing.

The only sneaky part of the whole airplane is the rudder "kick-out" mechanism. The basic principle is that up aileron actuates a wire lever that forces the rudder outboard while down aileron moves the lever away from the rudder which is held in neutral by the return spring. The slot in the nylon aileron horn allows the other end of the lever to move freely in the proper directions. The wire lever is built as follows: clamp a piece of 3/32" music wire in a vise and then wrap a section of

ABOUT THE AUTHOR

Frank B. Baker, age 50, has been flying models for 43 years and has been in R/C since 1954. He is a member of the Madison Area Radio Control Society (MARCS) that also includes well known designers Owen Kampan and Romey Bukholt on its roster. Two previous articles authored by Frank were published by RCM, a rudder only B-24 and a Stand-Off Scale P-51 presently kitted by Fliteglass. His major interest in R/C is multi-engined 1/2A scale and a B-29, B-25, B-26 and a P38 are currently flying. When not engaged in R/C, Frank is a professor of Educational Psychology at the University of Wisconsin. In 1969, he rebuilt a full-size Piper J-3 and is well known locally for his numerous cross country adventures in his Cub.

1/16" wire around it three times. I used 1/16" welding rod, the copper coated type for gas welding, as it is softer than music wire, but the latter will work. Once the spiral is wound, bend the upper and lower sections as shown on the plans. Make one right and one left. Solder a washer to the top and bottom of the coil section to provide a flat top and bottom surface. Mount the wire lever on the wing with a 2-56 bolt. Install the slotted aileron horn and check for proper action. You will probably need to do some minor bending of the wire and carving on the horn slot to achieve free action. Next, lay a bead of white glue in the wing slot and install the aileron control cable. Also epoxy it to the 3/16" support balsa on the inside of the rudder. The aileron control clevis goes below the rudder throw mechanism. At the center of the wing, the yellow plastic tubing comes slightly out of the wing. The two cable ends and the wire for the aileron servo link are soldered together at the center. You will have to slide the aileron servo arm over the wire link after the servo is installed.

Once the wing is done, the fuselage can be completed. Mount the wing using the pan screws. Lightly glue on the foam hatch and the wing block. Use a sharp knife and sandpaper to shape the foam block. Be careful with the sandpaper as too much pressure will tear the foam. The hatch was designed to use a 2" thick chunk of the blue insulation foam available from lumber yards. One panel will serve your building needs for years. You may even be able to scrounge enough at the lumber yard from damaged panels. After shaping, remove the hatch block and install the front 1/64" plywood face and the 1/8" dowel. At the bottom rear of the hatch, cut a 1/16" deep recess to hold a 1" square piece of 1/16" plywood. Cut a strip of brass shim stock 1/2" wide and 1" long. Bend a sharp V in the last 3/8" and fit it to the balsa that holds the leading edge of the wing. Lay this brass strip in the recess in the hatch and epoxy the plywood plate on top of it. While the wing is mounted, carve the wing strakes from 1" foam and fit them to the leading edge of the wing. **Note:** They will be glued to the fuselage side but not to the wing. The engine cowl can also be added. The cowl can be built up from balsa or made of foam and fiberglass using the "balloon method." The plywood ring adds strength to the thin cowl edge behind the propeller.

Most versions of the Varieze are done in white with a minimum of trim, thus the model was covered completely with white Solarfilm. Be sure to completely cover all foam surfaces so they are not exposed to fuel. Although the plans and the photos show wheel pants, I would not recommend them as they are a nuisance on 1/2A airplanes.

Flying

As set up on the plans, the elevator should be somewhat insensitive while the ailerons are very sensitive due to the large throw needed to make the kick-out rudders work. Note that the elevator action is backwards from normal practice. Pulling back on the transmitter stick should make the elevator go down to cause the canard to lift. I installed a Sullivan 1 ounce tank from my pattern plane and left the clunk as is. It seems to work well even though logic says the clunk should be at the rear of the tank. Both a Cox three bladed and Grish 5/4 two bladed pusher propellers have been used, but the latter is preferred. The Center of Gravity should be 1¾" ahead of the leading edge of the wing.

If you have the proper incidence settings and C.G., all should go well. Like all 1/2A planes, do not launch unless the engine is peaked. I always hand launch and have yet to hit the prop with my hand. Once airborne, the Varieze flies like a slow Pacer. It is very stable, will loop, has a lightning roll, and a good glide. Due to the built-in incidence, the canard stalls before the main wing and a mushy condition, rather than a stall, results. If you slow the plane up at the top of a loop, it will snap roll to the upright position and keep on flying. I have been unable to sustain inverted flight.

Let me say a final word about trim if your plane does not fly off the bench. The crucial factors are canard incidence, elevator throw, C.G., and engine thrust line. If the plane enters a mushy condition whenever up elevator is used, reduce the throw. If it persists, reduce the canard incidence. If it flies but requires down elevator to maintain level flight, move the C.G. forward. A bit more down thrust also helps. The Varieze is somewhat insensitive to forward C.G., but very sensitive to rearward C.G. Thus, to err towards the front is best.

In the air, the Varieze is an eye catching plane and you should enjoy flying something out of the modified Taurus mold.

BILL OF MATERIALS

Balsa
(all medium unless specified)
2 — 1/2 x 1½ x 5 soft.
1 — 3/8 x 3 x 24 hard.
2 — 1/4 x 5/16 x 36 hard.
2 — 1/4 x 36 trailing edge stock.
1 — 1/4 x 3 x 6.
2 — 3/16 x 3 x 36.
1 — 1/8 x 3 x 36.
1 — 2 x 3 x 2½ soft.
1 — 1 x 3 x 5.

Plywood
1 — 1/4 x 2 x 2½.
1 — 3/32 x 1 x 10.
1 — 1/16 x 6 x 12.

Foam
1 — 2 x 3 x 19 blue construction foam.

Music wire
1 — 3/32 dia x 36.
2 — 1/16 dia x 6 M.W. or welding rod.
2 — .025 dia x 4.

Miscellaneous
2 — Sullivan GRC-3 Gold'N-Rod cable in tubing.
2 — large aileron horns.
2 — small Goldberg nylon clevis.
12 — small Klett hinges.
1 — Kraft Hayes KM 0.5 engine mount
6 — 2-56 x 1" bolts
4 — 2-56 x 1/2 bolts.
4 — 2-56 blind nuts.
2 — #6 x 3/4 pan screws.
1 — 1⅛" spinner.
1 — Grish 5/4 pusher prop.
1 — 1¼" Perfect wheel.
2 — 1½" Perfect wheels.
1 — roll white Solarfilm.
1 — elevator horn. □

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