Pilot Flight Check: Rutan Defiant

Is the four-seat offspring of the VariViggen and VariEze canards the shape of production lightplanes to come?

by DON DOWNIE / AOPA 188441

■■ Just two weeks after Burt Rutan first flew his new four-place Defiant push-pull twin, we joined him over the smoggy skies of the Los Angeles Basin. With two 160-hp Lycoming engines and fixed-pitch propellers, the airplane produced true airspeeds up to 186 knots in level flight and attained a positive rate of climb during a single-engine go-around with one propeller windmilling.

Rutan reported that the only structural change dictated so far was modification of the stiffness of the nosegear steering push rod. "This has been the cleanest initial test program we have seen on any type of aircraft," he said.

The newest push-pull, which could well become the basic design for light twins of the future, is built for a no-procedure-for-engine-failure concept. Considering the results of our flights with Rutan, N78RA certainly fulfills this goal.

The aircraft is significant for the many things it does not require that save cost, weight and complexity. Not to be found are a tailcone, horizontal tail, flaps, cowl flaps, oil coolers, controllable props, retractable main gear and engine nacelles. The wetted area (total aircraft surface) is only 50% of that of the Grumman Cougar.

Everything on the prototype is built from scratch except the nose gear, which came from a Mooney, and the canopy support, from an Audi automobile. The resulting airplane has an empty weight of only 1,585 pounds, fully IFR equipped, with soundproofing and upholstery. With full 90 gallons of fuel, the Defiant can carry four adults and 75 pounds of baggage up to 1,120 nautical miles with no reserve. Maximum two-engine gross weight rate of climb is 1,600 fpm.

The payoff for the novel canard configuration, however, is the single-engine rate of climb with gear down and prop windmilling, which shows a negative rate of climb on all other light twins, while the canard model will still climb initially at 280 fpm (330 fpm with gear up).

The primary goal of this design is to provide a modern twin-engine airplane that "defies all the common assumptions about current production twin-engine aircraft in pilot skill required, safety, performance, construction and handling." Trim changes are almost nonexistent, as we found out, when either engine is

shut down. Because of careful updraft engine cowling design, cylinder-head temperatures actually decrease by 20 degrees (from 370°F) with a full-power, single-engine climb as compared to a normal two-engine cruise.

The canard has little or no adverse yaw. With feet on the floor and brisk aileron applied, the skid ball deflected less than ¼ width. With the side stick released after raising the nose to slow to 87 knots, the nose lowered and the airplane built up speeds to 127 knots and damped itself out to the earlier trim speed of 100 knots within two slight oscillations. Going from idle to full-power on both engines produces only a very slight nose-up pitch—less than one pound stick force.

Elevators on the canard and ailerons on the back wing are hinged to the trailing edge of the structure with control pressures applied by pushrods. The elevator doubles as a landing flap as the stick comes back. Wing structure is a full-thickness, foam core using an I-beam, unidirectional S-glass spar (a high-control fiberglass) with skins of three-ply E-glass/epoxy. The solid wing eliminates drain holes or water traps.

Surprisingly, the new Rutan twin does not have the fatiguing out-of-sync propeller beat found in conventional or other push-pull twins when the propellers are not rotating at the same speed. This pleasant hush is caused primarily by the high damping of the fixed-pitch Kevlar wood props. Additional noise suppression comes from two Flight Research mufflers, which are similar to mufflers on the Cessna 152.

The Lycoming O-320 engines in the prototype were originally 150-hp versions that have been majored and modified to produce 160 hp.

The cabin is big. Inside dimensions are two inches wider at the elbows, eight inches longer in the cabin, six inches more knee room with the back seat and three feet more baggage volume than the Beech Duchess. There's ample leg room for tall pilots. Rutan considers the cabin already more quiet than his popular VariEze.

The cockpit step has yet to be added, although designed, so it takes a boost to get into the cockpit. Rutan plans a triangular, two-step design that will fold flush with the fuselage.

A left-hand control stick is located on the side of the cockpit with cutouts already made for the right-hand controls. Throttles are on the middle console with a simple split handle that points toward the engine being controlled. The left throttle controls the front engine and has a broad point on the handle headed forward. Mixture control verniers are forward of the throttles with the forward control attached to the forward engine. Prop controls, there are none.

Fuel goes into two, 46-gallon composite wet tanks, which are in the wing strakes located forward of the leading edge of the main wing. On the prototype, see-through plastic gauges aft of the front seats indicate the fuel level.

Rutan is very critical of existing fuel gauges and plans a six-gallon fuel sump for each tank. Fuel quantity in the sump can be readily measured within 10%, making flights down to the last gallon or two of fuel acceptable. Low-fuel warning lights will be added to each sump.

During these early flights, rear seats have not yet been added. The clamshell canopy has a simple secondary lock that keeps the greenhouse from opening more than two inches if it is not locked.

With only the rear engine running, we called Brackett Field's ground control and taxied down the hot ramp. In the run-up area, Rutan fired up the front engine and we closed the canopy to keep the wind out. A simple mag check showed that we were ready to go.

Acceleration is rapid. Skeptics of the canard design say that excessive ground roll is required to become airborne, but the Defiant broke ground in about 1,100 feet at an indicated 69 knots, with two aboard, 150 pounds ballast and 50% fuel. The field's density altitude was 4,200 feet. In gross weight testing, N78RA has carried full fuel, two pilots and 550 pounds of ballast.

Our best rate-of-climb speed, for demonstration purposes, was 90 knots

with a deck angle measured on the cockpit inclinometer of 20 degrees. At this extreme nose-up angle, visibility over the nose was marginal at best. A normal cruise-climb speed of 120 knots gives a more-than-adequate visibility.

Our departure turn was at 100 knots and the rate of climb between 1,600 and 2,000 fpm at 600 pounds under full gross weight.

Without any soundproofing and firewall cutouts covered only with a piece of .016-inch-thick stainless steel firewall, the cabin noise level was 94 decibels. Rutan figures that 84 decibels is attainable on a well-padded production unit.

We climbed rapidly, at 1,500 fpm, above the smog level and temperature inversion. A check of the oil- and head-temperature gauges showed cool engines. Surprisingly, the rear engine cools better than the front, and it is not possible to stop the rear engine in flight because of the slipstream of the front engine. However, we did slow down to an indicated 70 knots, cut the mixture and switches on the front engine and finally stopped its prop.

The Rutan twin cruises over 180 knots, boasts do-nothing simplicity in case of single-engine go-around. Designer Rutan points out unconventional belly-mounted rudder. Photos by the author.

With the front prop stopped, 2,350 rpm produced 80% power on the rear engine at 6,000 feet. Density altitude was 9,000 feet, and we were able to climb at 100 to 150 fpm at 75 knots.

Full-power application with either engine out produced almost no trim change. Rutan said that he plans to offset the thrust line of the front engine 2.5 degrees to the right for hands-off, feet-off, straight-ahead climbs. During our flight, the engine had been installed without this offset and moderate right rudder was required for a front-engine maximum-rate climb. Part of the built-in stability of the canard comes from the fact that a positive up-gust on the front wing will float the trailing-edge elevator up and deflect the nose down. This is opposite from conventional design and produces a built-in damping.

The electrical system on the new canard is completely redundant, with an alternator and battery available for each engine. Thus, with either engine

Two generations of push-pull twins share the ramp at Brackett Field, Calif. The Defiant could spur the simple-twin concept begun by the Cessna Skymaster—but will it be produced?

RUTAN DEFIANT

Specifications

Engines	(2) Lycoming O-320, 160 hp each
Propellers	69 in, fixed-pitch
Wing span	29 ft 2 in
Wing area	127.3 sq ft
Wing loading	22 lb/sq ft
Passengers and crew	4
Empty weight	1,585 lb
Useful load	1,315 lb
Gross weight	2,900 lb
Power loading	9.06 lb/hp
Fuel capacity (standard)	90 gal

Performance

Rate of climb	1,750 fpm
Single-engine rate of climb	390 fpm
Maximum cruise speed (65% power, 12,000 ft)	188 kt
Range (no reserve)	1,120 nm
Stall speed (clean)	64 kt
Stall speed (gear and flaps down)	64 kt

RUTAN DEFIANT continued

shut down, alternator and battery power can be used selectively or even from the "dead" engine, since normally the fixed-pitch prop will windmill at about 1,100 rpm on the rear engine with full throttle on the front powerplant.

The nonstandard, short, side-mounted stick is easy to control. Stick forces are nominal. The design will make a great instrument platform because of this inherent stability and very small trim changes, as well as the obvious advantage of no procedures required in case of either engine failure. Just about all you might want to do is retract the nose gear to gain an extra 50 fpm of climb, single-engine, turn the crossfeed on if you want to use all your fuel on the operative engine, and turn the magnetos off on the "dead" engine—none of which are actually required to climb.

We tried steep turns and watched the elevators, actually the trailing edge of the canard, as stick forces were applied. With a 2-G load as found in a 60-degree bank, the 22-foot canard up front will flex up 1½ inches at the tips. In the rough air we flew, there was slight visible flexing, though the design does have a built-in elasticity to help produce a smooth ride in rough air. Kevlar, 10 times the cost of fiberglass and twice as stiff and strong, is used for vertical fins (winglets), ailerons, elevators, main landing gear and rudder. The remainder of the structure is fiberglass and foam. Both steel-tube engine mounts fasten to the main fuselage structure by four ⅜-inch bolts.

Before letting down for a series of touch-and-goes at Chino Airport we demonstrated maximum cruise speed capabilities. In level flight at 5,500 feet, outside temperature 85°F, a density altitude of 8,400 feet and an indicated air speed of 165 knots (186 knots true), there was no increase in noise, vibration or engine speed. The airplane's optimum altitude is 12,000 feet where with 2,650 rpm it produces just 55% power, resulting in a true airspeed of 180 knots and a fuel consumption of 8.1 gph on each engine. Rutan told us that his fastest dive speeds to date were at 11,000 feet, 195 knots indicated (235 knots true). Red line had not yet been determined.

We had to make two 360s to drop 4,000 feet to enter Chino's traffic pattern. Throughout all maneuvers, except maximum performance demonstration climbs, visibility was excellent. We slowed to an indicated 120 knots to extend the nose gear. Rutan went through his ever-present checklist, and came in on a flat, 85-knot approach. The canard can be slipped to spill off altitude without flaps. The new pilot should learn to get the canard slowed down far out in the pattern and carry it in on power.

With the goof-proof centerline thrust and simple do-nothing configuration in case of an engine failure, this power-on dragged-in approach is a routine conservative procedure.

We shot four landing approaches, the first three in one or the other engine-out configurations where there was a zoom capability from 80 knots from one-engine power application to between 1,000 and 1,200 fpm followed by a steady rate of climb of 600 fpm with the critical rear engine at idle power. These pull-ups were made with hands off the controls, since there was neither yaw nor pitch-up. Compared with conventional multi-engine characteristics, these capabilities were outstanding.

Much of the performance on this radical new twin is credited by the designer to Dr. Richard Eppler of Stuttgart University, who computed the curves for the semilaminar flow airfoils to operate efficiently even with a layer of dirty bugs. The fixed, vertical winglets add longitudinal stability and decrease spanwise flow. The existing belly-mounted single rudder is just under the pilot's rudder pedals, forward of the center of balance. It produces no swerve because the pivot point is well forward of the center of pressure. Rutan anticipates a design change to shorter twin forward rudders since the existing 22-inch unit could be snagged by snow or runway debris.

With a relatively short fuselage—almost all taken up by engine compartments, passengers, fuel or baggage—there is very little unproductive structure.

Rutan says that he's having so much fun with the new airplane that he has no firm marketing plans and will not sell it to anyone at the present time. He kept his VariViggen for 18 months as a personal fun airplane before marketing plans for home-builders.

Howard "Pug" Piper, involved in the original development, has been one of the first to evaluate the new radical design for flight characteristics and possible production. Rutan wants to turn the design over "to the company I think has the best chance of producing it successfully. I don't want someone to purchase the design and then bury it."

Somehow, it doesn't seem likely that the Defiant will be an easy airplane to keep down. □