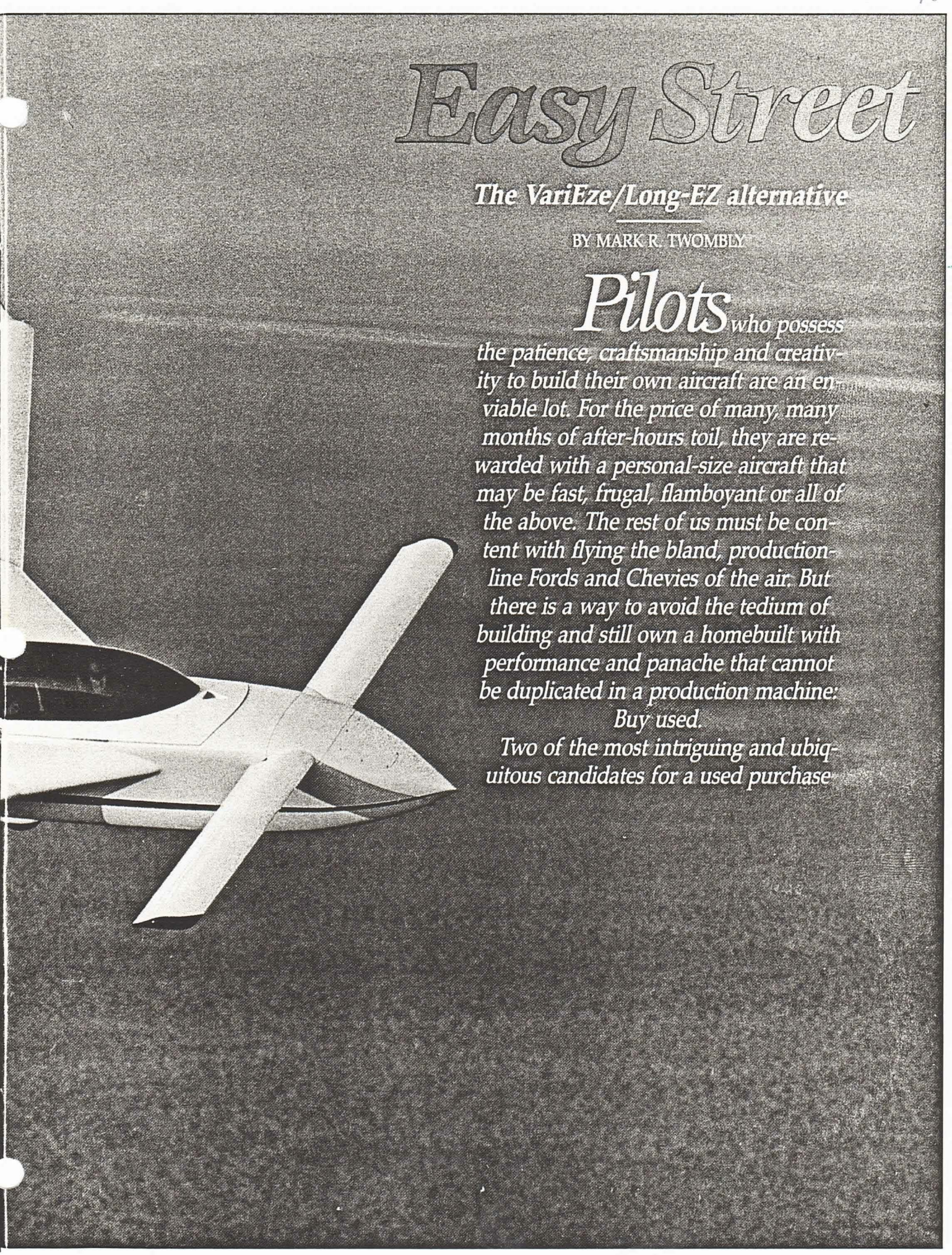
Easy Street

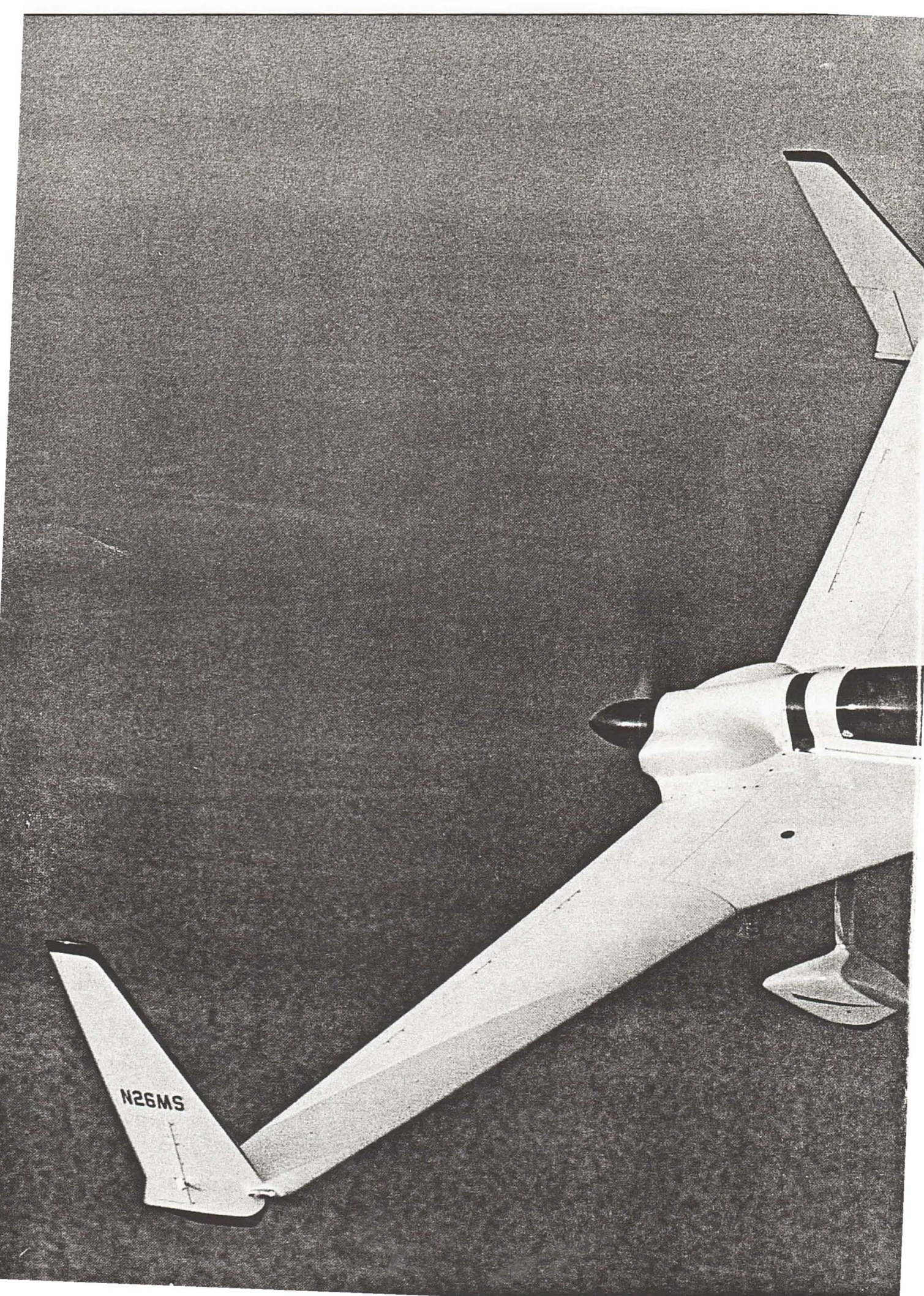
The VariEze/Long-EZ alternative

BY MARK R. TWOMBLY



Pilots who possess the patience, craftsmanship and creativity to build their own aircraft are an enviable lot. For the price of many, many months of after-hours toil, they are rewarded with a personal-size aircraft that may be fast, frugal, flamboyant or all of the above. The rest of us must be content with flying the bland, production-line Fords and Chevies of the air. But there is a way to avoid the tedium of building and still own a homebuilt with performance and panache that cannot be duplicated in a production machine: Buy used.

Two of the most intriguing and ubiquitous candidates for a used purchase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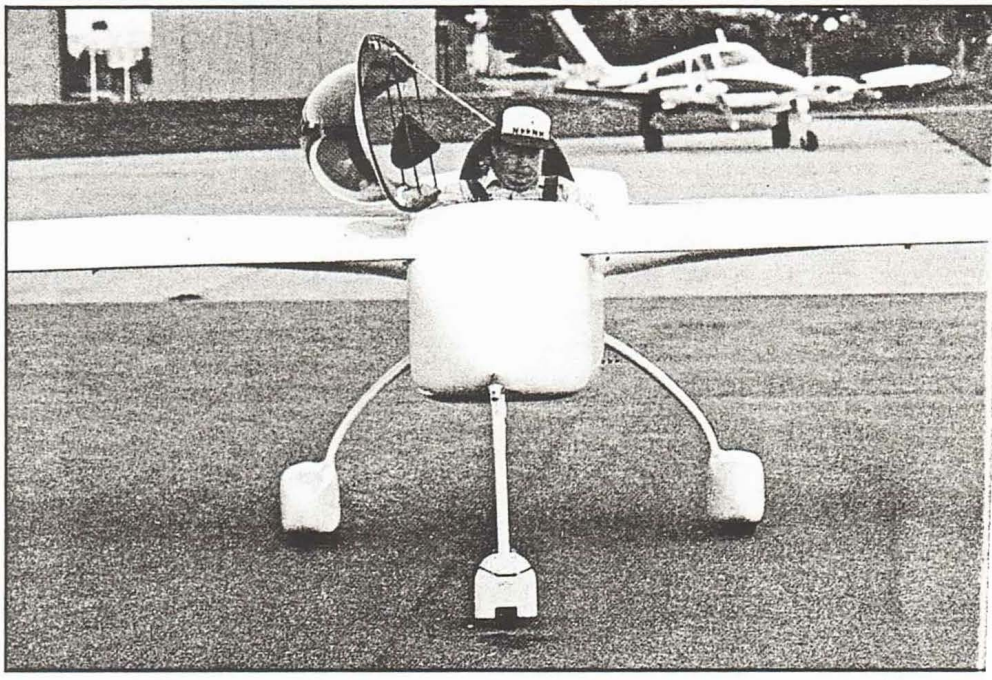
are the Rutan Aircraft Factory (RAF) VariEze and Long-EZ. An estimated 400 to 500 VariEzes are flying and an equal number of Long-EZs, according to RAF. More will take to the air, since RAF has sold about 2,000 sets of plans for each design, and most builders take several years to complete their basement or garage projects.

Prices for completed VariEzes begin at about $12,000. A full gyro panel, cross-country avionics, an attractive interior and sharp exterior paint scheme can raise the price considerably. Long-EZs, which have a more powerful engine, greater fuel and baggage capacity, lower takeoff and landing speeds and more benign handling characteristics, can fetch two to four times the price of a VariEze.

The VariEze has been around for more than a decade and the Long-EZ for about seven years, but they still attract gawkers wherever they are flown. From the fiberglass and foam construction and the forward and rear wings to the pusher engine and propeller, tandem-seat cockpit with sidestick controller and nose-to-the-earth resting posture, every aspect of an Eze-EZ oozes radical chic.

VariEzes launched a revolution in homebuilding by popularizing composite materials and relatively quick construction methods compared to most other do-it-yourself aircraft. The VariEze and Long-EZ also won the designer, E. L. (Burt) Rutan, AOPA 795261, national prominence as a creative, maverick engineer who championed the use of canards for drag reduction and stall and spin resistance. Two of his more recent designs, the Beech Starship and *Voyager*, have extended his fame far beyond the homebuilt community.



Red Morris dons his Long-EZ and prepares to lower the flip-top canopy. High speed on low power is possible because of the low frontal area of the tandem-seat fuselage, smaller wetted area of the tail-less design and smooth, rivet-free fiberglass surfaces.

Buying a used or partially completed project may be the only way to get a VariEze or Long-EZ. In July 1985 Rutan announced that because of sharply decreased sales and the threat of product liability suits, RAF no longer would sell homebuilder plans for any of its designs, including the VariViggen, VariEze, Long-EZ, Solitaire motorglider and Defiant centerline-thrust twin. An additional factor in RAF's withdrawal from homebuilt designs was Scaled Composites, a company Rutan founded in 1982 next to the small RAF hangar at the Mojave, California, airport. Rutan had little time to spend at RAF because of the press of business at Scaled Composites, at which he designs and develops prototype aircraft under contract. One of its first projects was to build and flight-test an 85-percent-scale prototype of the Beech Starship. Beech later bought Scaled Composites and named Rutan to Beech's board of directors.

RAF still provides support to builders. The office is open Tuesdays and Fridays to answer telephone and mail inquiries. RAF also publishes a quarterly newsletter, *The Canard Pusher*, which contains factory and builder news, construction and operational tips and solutions to problems reported by builders. The newsletter is the factory's official method of announcing changes in the design, construction and operation of RAF aircraft. Changes are classified as either optional, desired or mandatory, in some cases requiring immediate

grounding of aircraft. RAF concedes that it cannot enforce compliance with mandatory changes, but the company's stated policy is to "provide information to the homebuilder in the form of recommendations that, in our opinion, are required for him [or her, presumably] to achieve a satisfactory level of flight safety."

A subscription to *The Canard Pusher* is mandatory for builders and should be considered mandatory for anyone who buys a used VariEze or Long-EZ. An annual subscription is $14. Individual copies of back issues can be ordered for $3.50 each. VariEze information is contained in newsletters 10 through 51 (51 being the latest available as this issue of *Pilot* went to press). Long-EZ information is contained in newsletters 24 through 51. (Contact Rutan Aircraft Factory, Incorporated, Building 13, Airport, Mojave, California 93501; telephone 805/824-2645.)

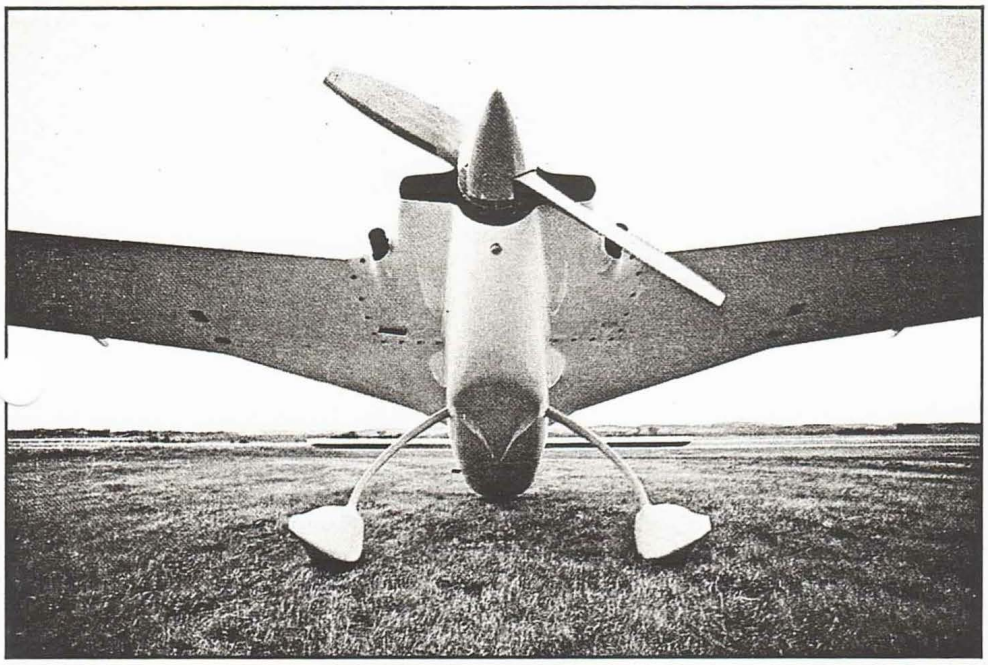
VariEzes and Long-EZs were designed to provide inexpensive, fast, cross-country sport flying. Factory performance figures for a 100-horsepower VariEze at a gross weight of 1,050 pounds promise a 1,500-foot-per-minute sea-level rate of climb and a 148 KTAS cruise at 8,000 feet on 50-percent power. At that altitude and power setting, the VariEze should deliver about 28 nautical miles per gallon for a range of about 700 nm, according to the owner's manual. Maximum level speed at sea level is 178 knots, according to RAF.

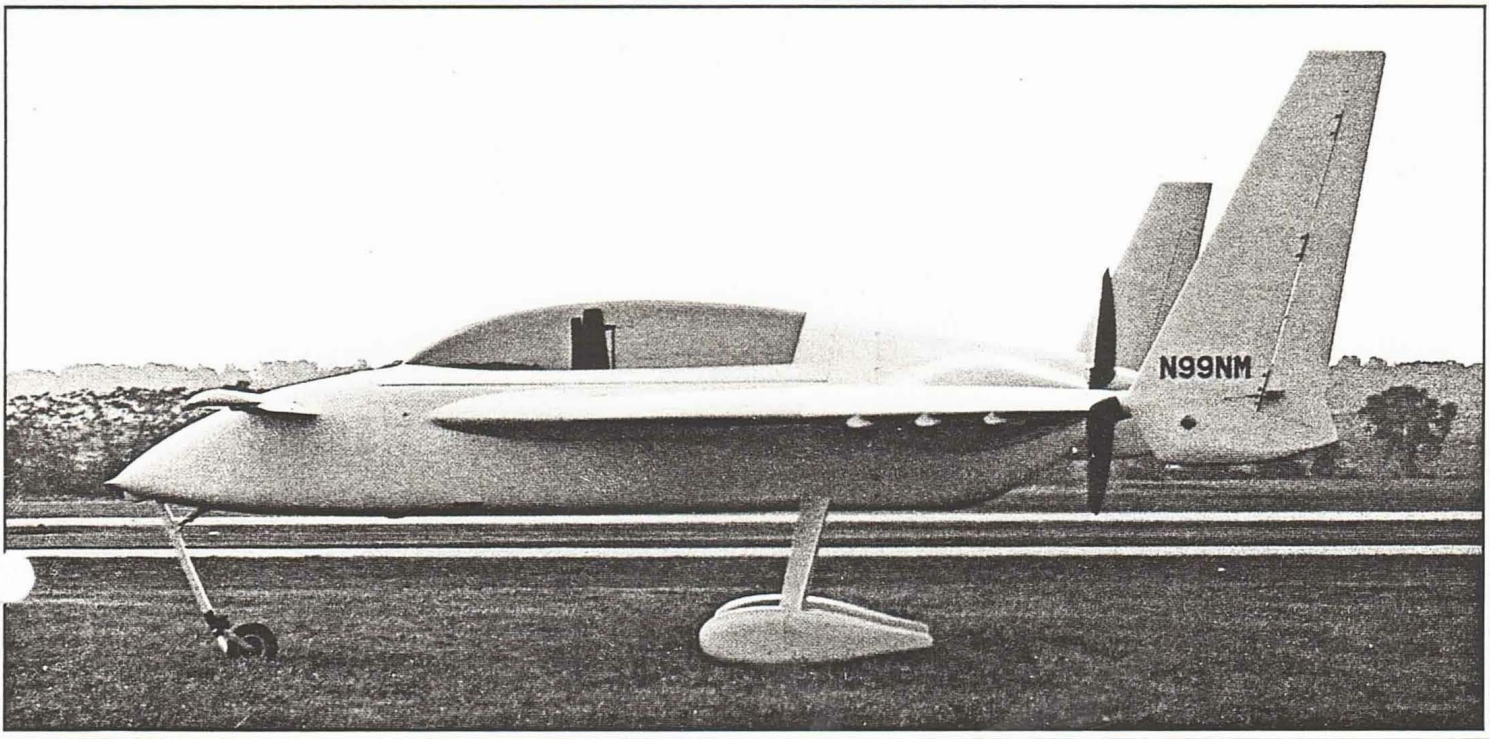
A 115-hp Long-EZ at a gross weight of 1,400 pounds will climb at about 1,000 fpm at sea level, says RAF. The book economy cruise speed at 12,000 feet and 50-percent power—four gallons per hour—is 137 KTAS. Maximum level speed is 167 knots at sea level.

No two homebuilt aircraft are identical, and performance hinges on engine power, propeller efficiency, weight and the care the builder has taken in adhering to RAF specifications. The VariEze owners's manual states that cruise performance figures are based on flight tests of RAF's own aircraft and verified by other homebuilders, but actual cruise speeds may be eight to 17 knots slower.

The VariEze was Rutan's first composite aircraft but his second homebuilt project. The first was the homely, mostly wooden, VariViggen, designed when Rutan was an undergraduate aeronautical engineer at California Polytechnic Institute. The design was loosely based on the Saab Viggen, a sleek, Swedish canard-configured military fighter.

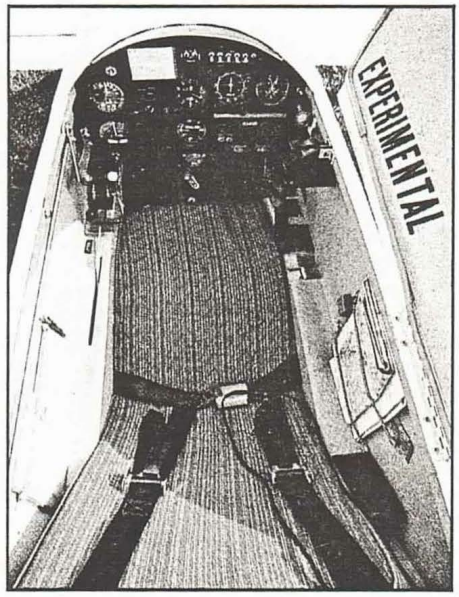
The VariViggen embodied Rutan's developing concepts for a cross-country sport aircraft with safe, low-speed handling. Central to all of Rutan's designs is a high-aspect-ratio, cambered, high-lift canard. By obviating the need for a down-loading empennage to balance the up-loading of the main wing, the Rutan canard contributes to lower mass, weight and wetted area. More impor-





Morris wraps an arm around the canard of his Long-EZ to lift the snout and crank the nosewheel down. A small rubber disk protects the nose from scuffing when the EZ is grazing.

Head of Long-EZ backseater is scant inches from engine. Headset cuts noise to a dull roar.



Modestly sized VariEze panel accommodates basic avionics and day-VFR instrumentation.

tant, it provides stall and spin resistance. The angle of incidence of the canard is set higher than that of the main wing, so the canard will stall before the main wing. At stall, the nose drops until regaining lift. If the control stick is held back, the nose will bob as the canard alternately stalls and regains lift, but the main wing continues to fly with no loss of roll or yaw control.

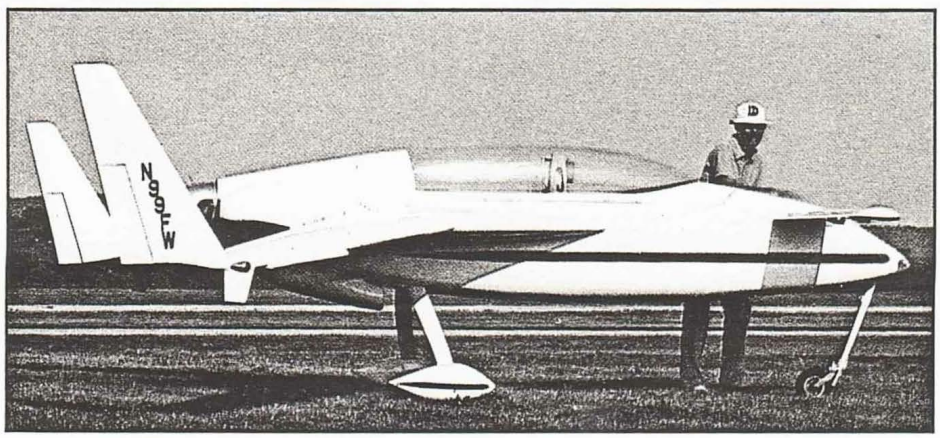
In 1969 Rutan formed Rutan Aircraft Factory as a part-time business to develop homebuilder plans for the VariViggen. RAF moved into rented ex-military barracks at the Mojave airport in July 1974, and two months later Rutan began work on the VariEze. The goal was to achieve better speed and fuel efficiency than the VariViggen could provide without sacrificing safety and handling. Rutan also wanted to offer an inexpensive design that could be fabricated quickly and easily by amateurs; hence the name VariEze.

Originally the VariEze was to be an aluminum aircraft. After studying molded, composite construction methods then being used by some European sailplane manufacturers, Rutan became convinced that fiberglass offered greater flexibility and ease in achieving complex shapes, with no compromise in structural integrity or weight. The prototype VariEze, made of fiberglass and plastic foam and powered by a 62-hp converted Volkswagen engine, first flew in May 1975.

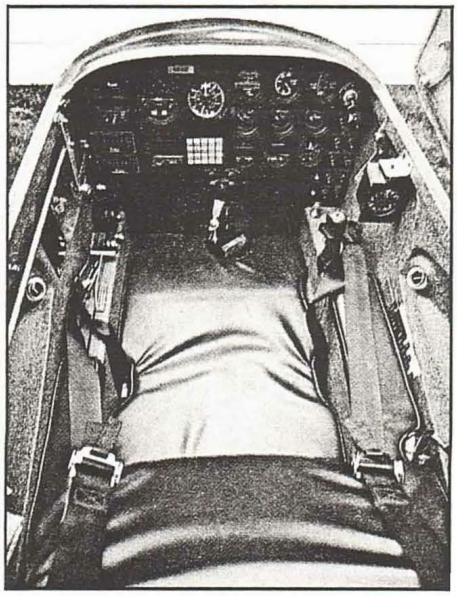
The prototype was flown to the Experimental Aircraft Association's annual fly-in at Oshkosh, Wisconsin, for its public debut. It was a sensation. Homebuilders, numbed by the usual collection of biplanes and designer oddities from backyard aerodynamicists, gravitated to the VariEze with its rakish good looks and performance claims.

Plans for the original VariEze were never sold, however. The Volkswagen engine proved unreliable, and the prototype exhibited undesirable flight characteristics, including poor low-speed roll control and unacceptably high stall and landing speeds. A second prototype with a new canard and powered by an 85-hp Continental engine, was built, and it was first flown in March 1976. At Oshkosh 1976, RAF began selling VariEze plans.

The VariEze airframe consists of a fiberglass center-section spar with fiber-



Fred Wimberly steadies his VariEze. The cockpit compares in size to the Long-EZ's, but VariEze wings have more sweep, less span and smaller fuel tanks and winglets.



Short-throw sidestick and narrow, reclining cockpit gives Mach 2 image to Mach .2 EZ.

glass outer wing panel spars buried in foam blocks. There are no stringers, formers or ribs. The skin, the primary structural component of the aircraft, is made from fiberglass plies cured with epoxy. To construct a wing, the builder cuts paper airfoil templates from plans supplied by the factory, tacks the templates to blocks of wood and shapes the wood to the patterns. A wooden template is placed at each end of a length of foam, and a metal wire attached to a small electric transformer is stretched between the blocks. The wire is heated by the resistance of the electric current and is pulled over the wooden templates, cutting through the rigid foam like soft butter. Fiberglass cloth is draped over the foam; epoxy is applied, and the layup is left to cure at room temperature. The fuselage is formed from thin foam panels covered with fiberglass. RAF insists that all of its aircraft be painted with a base coat of white acrylic lacquer to reflect ultraviolet rays, which can deteriorate the epoxied fiberglass.

Fuel is contained in two 12-gallon wing tanks and a two-gallon fuselage tank intended as a 30-minute reserve. Sight gauges serve as fuel quantity indicators. A three-way cockpit selector switch controls the fuel supply to the engine.

The VariEze was the first aircraft to incorporate winglets developed by Dr. Richard Whitcomb of the National Aeronautics and Space Administration. The large winglets provide yaw stability and control and reduce induced drag by blocking span-wise flow of air from the underside to the top of the wing. Each winglet incorporates a one-way, outward-deflecting rudder. An underbelly scoop directs air to the engine for updraft cooling.

The first VariEzes used elevons, a combination of ailerons and elevator, on the canard for pitch and roll control. It soon became apparent that not all the low-speed control problems afflicting the first prototype had been cured. Some builders experienced poor aileron response and even control reversal. RAF mandated changing elevons to a slotted elevator and installing conventional ailerons on the main wings. Main wing leading edge droops were required to correct a wing-rocking tendency at stall. A belly flap was added to increase the descent rate of the aerodynamically slippery VariEze.

RAF has approved a variety of engines for installation on the VariEze, including the Continental A-75, A-80, C-75, C-85, C-90 and O-200 and the Lycoming O-235 minus starter and alternator (to keep the weight at 215 pounds). Two-blade wooden propellers must be used. Maximum allowable weight of the engine, propeller, propeller extension, exhaust system and spinner is 240 pounds, according to the factory.

Not long after the VariEze was introduced, Continental stopped manufacturing new O-200 engines, which most builders favored. Used O-200s became difficult to obtain at prices builders could afford. Rutan decided to increase the size of the VariEze to accommodate larger, heavier engines—specifically the Lycoming O-235 with a complete electrical system. In June 1979 RAF flew the prototype Long-EZ, which featured VariEze outer wing panels attached to a larger center section and a keel-like rudder under the nose.

The design was substantially modified as a result of flight tests throughout the summer. In August the final configuration was approved with a new wing and larger winglets with rudders. Fuel capacity was increased to 52 gallons in two wing-strake tanks. The VariEze's header tank was eliminated. Cockpit dimensions did not change significantly, but baggage space, which is nonexistent in the VariEze, was provided in the wing roots.

The only engines approved by the factory for installation on a Long-EZ are the O-200 and O-235. The owner's manual states that a 130-hp Rolls-Royce O-240 or 125-hp Lycoming O-235-F may be satisfactory but have not been flight-tested. Factory advice notwithstanding, many builders have installed 150-hp and 160-hp Lycoming O-320 engines for better climb and cruise performance.

FAA records contain 104 reports of accidents and incidents involving VariEzes and 36 reports concerning Long-EZs from 1980 through May 1987. About 25 percent of VariEze accidents and incidents occurred during the pilots' first 10 hours in the aircraft, with many first-flight mishaps recorded. There were only two reports of first-flight accidents in the more docile Long-EZ and four involving pilots with fewer than 10 hours in the aircraft.

Nose-gear failures as a result of hard landings or mechanical defects and pi-

lots' neglecting to extend the nose gear for landing accounted for the largest share of VariEze and Long-EZ accidents and incidents. Fuel starvation due to defective tank selectors, nonstandard unvented fuel caps and fuel contamination was cited in several accidents. The only reported in-flight airframe failure involved a VariEze on a high-speed, low-altitude pass over an airport. According to the FAA report, the winglet and wing-tip skin failed due to improper construction.

The uninitiated may have difficulty distinguishing a VariEze from a Long-EZ unless the two are parked side by side. One clue is the Long-EZ's larger, straight winglets. VariEze winglets form an angle at the wingtip juncture. That was one of the few characteristics that distinguished Fred N. Wimberly's six-year-old VariEze from Nolan S. (Red) Morris's two-year-old Long-EZ when both appeared on the AOPA ramp in Frederick, Maryland.

Wimberly, AOPA 395810, a civilian electrical engineer with the U.S. Navy, bought his VariEze plans soon after the aircraft was introduced, in part because he had become disillusioned with a partially completed BD-5 kit purchased from an acquaintance. He spent three years building the VariEze and has flown it 650 hours with no loss of enthusiasm. "It still is the most fun you can have in the air," he said.

Morris, AOPA 806964, who operates his own vending service, has logged 250 hours in his Long-EZ, the first aircraft he has built and owned. Morris earned his pilot's license about 20 years ago but gave up flying until building his Long-EZ. Before flying it, he took instruction in a Cessna 152, then spent several hours with Wimberly, who is an instructor, in the VariEze. (RAF recommends that pilots be current in at least two aircraft types before attempting to fly a VariEze or Long-EZ and that checkouts be performed in calm conditions from a hard-surface runway of at least 3,500 feet. Grumman singles are considered good transition trainers because the differential braking and responsive handling are similar to RAF aircraft.)

VariEze and Long-EZ pilot and passenger sit in semireclining seats. Some builders complain that Rutan designed the cockpit for his own six-foot-plus frame, and unless adjustments to fixed

The price to be paid for high-flying cruise efficiency is to be found in tepid runway performance.

seat positions are made during construction, diminutive pilots must use a number of cushions. When latched shut, the expansive bubble canopy is only inches from one's head. In bright sunlight, the canopy seems more a solar collector than a windscreen. Sunglasses and a floppy chapeau are a must. The backseater is provided with a sidestick controller but no rudder pedals, power controls or instruments. The canard blocks a portion of the pilot's view, and the passenger cannot see past the front seat roll bar, but otherwise visibility is superb.

Weight restrictions prevent most builders from equipping their aircraft with electric starters, so proper hand-propping procedures must be observed (see "Pilot Advisory: The dangers and precautions of hand-propping," Sep-

tember 1986 *Pilot*, p. 68). Once the passenger is strapped in and the engine started, the pilot performs a ritual unique to the VariEze and Long-EZ: Grab the canard and lift the nose from its grazing position, then extend the nosewheel with the hand crank so the aircraft can stand on its own three legs. A VariEze or Long-EZ empty of occupants parked with the nosewheel extended would fall on its tail if it had one. Instead, the rear-mounted propeller and engine cowling take the hit.

Takeoff performance is weak. Rutan acknowledges that the tradeoff for cruise efficiency is runway performance. Acceleration is slow, and, with no propeller blast over a horizontal stabilizer, rotation speeds are high. A 100-hp VariEze at gross weight requires about 750 feet of runway at sea level in standard conditions to lift off, according to the owner's manual. A 115-hp Long-EZ requires 1,000 feet. Takeoff distances increase significantly in a crosswind because brakes must be used for directional control. The maximum crosswind component for takeoff is 15 knots; 20 knots for landing. Small tires, a stiff landing gear, steering by braking and high takeoff and landing speeds make the VariEze and Long-EZ poorly suited to turf strips and other soft or rough surfaces.

With two aboard and fuel tanks half-full on a hot June afternoon, Wimberly's VariEze lifted off from Frederick's asphalt runway at 70 KIAS and climbed at 95 KIAS at 900 fpm. Morris's Long-EZ broke ground at about the same speed but gained 1,200 fpm at 120 KIAS. With the engine but a few inches away, the noise level in the rear seat was high in both aircraft.

As twitchy as they appear on the ground, both the VariEze and Long-EZ are docile in the air. There may be an initial tendency to overcontrol because of the small amount of sidestick movement needed to initiate a change in pitch or bank, but control pressures are high enough to discourage gross mishandling. Turns can be made with no rudder input and only a small amount of adverse yaw. Adding rudder increases the turn rate markedly. Both the VariEze and Long-EZ can be trimmed for hands-off level flight, although there is a tendency to porpoise in turbulence, especially in the VariEze. Pulsing the controls causes a momentary pitch change with an immediate return to straight and level flight.

The VariEze stalled at about 52 KIAS at idle power with the stick held back. Except for a mild dutch roll, the aircraft was stable and controllable as it mushed along in a 250- to 500-fpm descent. The Long-EZ stalled at less than 52 KIAS, according to Morris's airspeed callouts. From the rear seat it was difficult to tell that the aircraft was stalled except for an occasional bob of the nose and a 250-fpm descent.

Returning to the airport, the VariEze descended at 1,000 fpm at 156 KIAS with a touch of power. The gear was cranked down at 105 knots, and Wimberly advised a pattern speed of about 78 KIAS. It could be flown 10 knots slower but at the expense of a nose-high attitude and reduced forward visibility. Target speed for short final is 70 KIAS with the belly flap deployed.

Morris prefers slightly higher approach and landing speeds in his Long-Ez for better control response and visibility. Patterns are flown at 90 KIAS, and final approach at 75 KIAS. Both rudders can be deflected, and the belly flap

extended to slow the aircraft on short final.

Proper landing technique in either aircraft calls for flaring to stop the descent, then flying the aircraft to touchdown. A full-stall, nose-high landing attitude will result in prolonged float and possible runway overshoot.

Despite futuristic styling and the personality of a micro-fighter—"I don't know how many Cessna 152s I've shot down," Wimberly grins—VariEzes and Long-EZs are well within the capabilities of proficient pilots. These are not airplanes for everyone, however. The range and endurance of a VariEze and Long-EZ make it dangerously easy for a VFR pilot to fly out of good weather into bad. The tiny instrument panel leaves little room for instruments and gauges considered required equipment on mass-production aircraft. Clever builders have found ways to shoehorn IFR avionics into the cockpit, but the additional weight reduces useful load, which is limited to begin with.

The canard pitches down in precipitation. Plans for a modified canard that does not change trim in rain have been offered by RAF. Other desirable changes specified by the factory, such as larger, more effective Long-EZ rudders and better brakes, may not have been incorporated on an aircraft that is up for sale.

VariEzes and Long-EZs have their foibles but have stood the test of hundreds of amateur airplane manufacturers and recreational pilots. For someone willing to accept the risks, buying one used can be the short cut to easy fun. □

SECOND-HAND DREAMS

can turn into nightmares.

Obvious pitfalls await the second owner of a composite homebuilt. For one, there is no way to conclusively determine how well the aircraft was put together. Homebuilders do not have to meet design and production standards that apply to aircraft certificated under federal aviation regulations. FAA inspectors examine homebuilts during the construction process and approve the final product, but no static or flight tests are required to verify structural integrity and handling characteristics.

The buyer of a used homebuilt must rely on a close inspection of the aircraft, advice from others familiar with the builder and the design, the report of the FAA inspector who approved the construction and, finally, the reputation of the manufacturer who produced the plans or kit.

Most homebuilders receive FAA repairman certification to maintain and inspect their own aircraft. It is one of the important money-saving advantages of homebuilts, but to the used buyer it means there probably has been no periodic evaluation of the aircraft's airworthiness by an objective professional. Repairman certification does not extend to the buyer of a used homebuilt. Unless the original builder agrees to inspect and maintain the aircraft for the new owner, the job will have to be done by an airframe and powerplant mechanic who may be unfamiliar with the design and therefore reluctant to tackle it.

Before agreeing to purchase someone else's homebuilt, arrange to fly it or one like it. Appearance is one thing, performance and handling another. You may be attracted by the former but disappointed by the latter.

Inspect the airframe closely. An internal failure will be evident by cracks in the paint or wrinkles in the skin. Minor tension, compression and delamination failures often can be repaired. Check for debonding of the fiberglass and epoxy by tapping the edge of a quarter on the skin. A sharp knocking sound indicates proper bonding; a dull thud signals debonding. Inspect control surface for freedom of movement and fuel and electrical systems for leaks and access. If possible, obtain the aircraft's owner's manual before inspection. The manual contains a detailed systems checkout procedure that a prospective purchaser could follow.

Have the aircraft weighed. Normal equipped empty weight for an O-200-powered VariEze with day VFR instrumentation is 580 pounds—750 pounds for a Long-EZ—according to RAF. Most builders exceed those figures, but if empty weight exceeds about 650 pounds for a VariEze or 850 pounds for a Long-EZ, it could be an indication that the builder used sloppy construction methods.

Examine the log books. Airframe and engine logs are required, just as with production aircraft. Check for RAF-mandated and recommended modifications, including revised canopy latch system, larger Long-EZ rudders, Long-EZ main gear for a VariEze and improved nose-gear system and new canard to eliminate pitch-down trim in rain.

Keep in mind the certification category of homebuilts: Experimental, Amateur-built. A VariEze or Long-EZ builder is the manufacturer of the aircraft and is free to second-guess RAF by making changes in the design and recommended construction so long as it passes muster with an FAA inspector. Let the buyer of an amateur-built aircraft beware. □

The unlikeliest astronaut

Mike Melvill's journey into space

BY DAVE HIRSCHMAN | PHOTO ILLUSTRATION BY MIKE FIZER

ALONE IN THE SLEEK, composite shell of an experimental spacecraft he helped build, suspended beneath the broad wings of the *White Knight* carrier airplane, test pilot Mike Melvill is glad to finally get busy.

The two aircraft have been ascending together for nearly an hour, and at 47,000 feet over the California desert, the *White Knight's* two General Electric J85 turbojets have lifted Melvill and *SpaceShipOne* as high as they can.

VIDEO EXTRA
View a video interview with Mike Melvill.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Melvill, then 63, goes through his final checklist items and removes the safety wire from the rocket motor arming switches as he prepares to fly into space. He's practiced this sequence of events thousands of times, but on June 21, 2004, it's for real.

At 7:50 a.m., *SpaceShipOne* is released from the pylon that's held it in place during its long ride to altitude, and as it falls, Melvill arms and then fires the rocket motor, which contains two fuels: 600 pounds of rubber and 3,020 pounds of liquefied nitrous oxide. It takes less than two seconds for the rocket motor to fire—but to Melvill, the wait seems far longer.

Then a violent jolt of acceleration shoots the craft forward and lets the pilot know the motor is blasting away at full power. The 3.5 Gs of straight-line, "eyeballs-in" acceleration throw Melvill against his seat back with roughly the same force as a top-fuel dragster at the starting line, and he pulls firmly on the control stick to point the nose of his craft straight up to the heavens. In addition to being pushed back, he's now being yanked down in his seat by 4 Gs.

The disorienting sensations require complete focus and absolute trust in the experimental avionics that show the aircraft's attitude, and Melvill handles the craft with the firmness and precision honed during three decades of flight tests on a wide range of unique aircraft ranging from a long-winged, glider-like drone to jets.

But just a few seconds into the fast-ascending flight, *SpaceShipOne* encounters a powerful wind shear in the upper levels of the atmosphere and the aircraft suddenly rolls 90 degrees to the right. Melvill counters with left rudder and left stick, but at the nearly supersonic speed the aircraft is now traveling, the controls are almost too stiff for the wiry former machinist to move. He uses a thumb switch that trims the aircraft to roll left and holds it, but the correction becomes too great. *SpaceShipOne* is rolling left and the trim won't reverse back to the right, and the spacecraft's speed and trajectory aren't exactly as planned.

Then there's a loud bang and a shudder runs through the airframe, and Melvill can't identify the sound. He considers cutting off the rocket motor, but he allows it to keep firing for the full 76 seconds until all the propellant is gone. At 180,000 feet, he's traveling Mach 2.9 and 2,150 miles per hour—and rising almost vertically.

SpaceShipOne reaches the top of its arc at 328,491 feet, or more than 100 kilometers above Earth. Melvill is weightless for three and a half minutes, and surveys the world through the many round windows in the aircraft's nose. He playfully opens a bag of peanut M&Ms and lets the colorful candy float throughout the cockpit—an impromptu gag for the onboard video camera.

While he tries to project an air of calm and confidence, the most harrowing part of the flight—reentry into the atmosphere—is still to come. And although Melvill is certain the plan of his friend, designer Burt Rutan, to bend *SpaceShipOne* into a draggy "shuttlecock" for a relatively low-speed descent will work, it's never been attempted from anywhere close to this altitude. With the blackness of space overhead, the brilliant blue line of the atmosphere on the horizon, and an entire vista of Southern California from the coast to the desert below, *SpaceShipOne* begins its long and irreversible fall.

Melvill pulls a handle that tilts the craft's twin tail booms up 75 degrees and prepares for what's sure to be a wild ride.

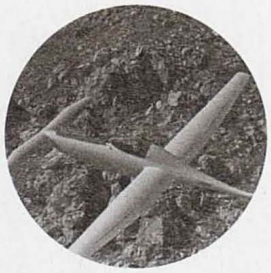
MIKE MELVILL WAS THE TEST PILOT FOR 10 OF BURT RUTAN'S 33 DESIGNS. HE DID MUCH OF THE ENVELOPE EXPANSION/FLIGHT TESTING ON ALL OF RUTAN'S DESIGNS UP TO *SPACESHIPONE*.

JANUARY 22, 1982

GRIZZLY
A STOL bush plane with all-composite materials. Test flight was 2.6 hours.

MAY 28, 1982

SOLITAIRE
A single-seat canard midwing motorglider.



SEPTEMBER 17, 1984

PREDATOR
Canard cropduster with a tractor engine and chemical hopper.

FEBRUARY 27, 1987

CM44
Canard pusher designed to carry electronic surveillance gear.

JANUARY 14, 1988

CATBIRD
5-place, single-engine aircraft briefly considered by Beechcraft as a production follow-on to the Bonanza.

COURTESY OF SCALED COMPOSITES, LLC; FAR LEFT BRIAN LOCKETT; FAR RIGHT ANDY HASH

The unanticipated roll during its ascent into space, and Melvill's hurried and abrupt corrections, has put *SpaceShipOne* about 22 miles away from its planned reentry point. Melvill is sure he can glide safely back to the Mojave Airport—but first he has to make it through the coming trial of reentry.

UNLIKELIEST ASTRONAUT. Mike Melvill doesn't fit the typical military-trained, academically overachieving astronaut profile. The South Africa native failed a math course and never finished high school. He raced motorcycles and became a machinist at 17. He married his childhood sweetheart, Sally, and they emigrated to the United States in the late 1960s. He became a U.S. citizen in 1972, and his motivation to fly was a dislike of airline travel—not a dream of exploration.

Melvill lived and worked in Muncie, Indiana, and his innate ability to diagnose and fix broken machinery had him traveling throughout the country to repair specialized industrial box-cutting machines. During the tedious waits in airport terminals, he came to believe that he could do his job more efficiently if he could fly his own airplane to job sites.

"Once I had my private, commercial, and instrument ratings, I began to look forward to people breaking things because it meant I got to fly," he said. "I thoroughly enjoyed all aspects of flying and wanted to do it as much as possible."

Melvill traveled to Oshkosh, Wisconsin, for the EAA convention in 1974 and bought a set of plans for an airplane called a VariViggen from designer Rutan, who was selling them from the backseat of his own VariViggen on the flight line. Melvill knew how to build things from blueprints, and he became the first customer to complete a VariViggen. He and Sally flew the odd-looking airplane to the West Coast for a business trip, then on a lark, decided to drop in on Rutan at his home base in Mojave.

Rutan was so impressed with Melvill's airplane, and with the man who built it, that he offered him a job on the spot. "He said he needed someone to answer builders' questions because all the customer service he had to provide took away from his real passion, which was designing new airplanes," Melvill said.

He and Sally talked about the offer during the long series of flights home to Indiana, and with her support, they moved to the dusty, windswept, tumbleweed-strewn high desert town of Mojave. "Sally recognized that this was a rare opportunity, and she saw the possibilities," Melvill said. "She encouraged me to go ahead and do it."

Now, Mojave and its bustling spaceport are firmly on the aviation map, and a welcome sign at the highway entrance boasts that it is the "Home of *SpaceShipOne*." (There's the Voyager Cafe at the center of the airfield named in honor of another Rutan design, and Scaled Composites is one of the city's largest private employers.) Melvill built the first Rutan-designed Long EZ from plans, and he flew the airplane around the world with the designer's brother, Dick Rutan, in his own Long EZ in 1997.

Melvill still owns and flies that two-seat aircraft, which has now logged more than 4,200 flight hours, and he and Sally (also a pilot) have taken it throughout North America during 32 years of flying.

MAY 9, 1993

QUIVER D1

Later known as the "Raptor" Melvill flew in the "saddle" on the back of the long-endurance UAV and had a very close call during testing.

JUNE 19, 1996

BOOMERANG

Rutan called this twin the "best for general aviation" because of its spin resistance in the event of an engine failure.

JULY 26, 1998

PROTEUS

High-altitude research aircraft.

MAY 20, 2003

WHITE KNIGHT

3-place, high-altitude, flexible aircraft.

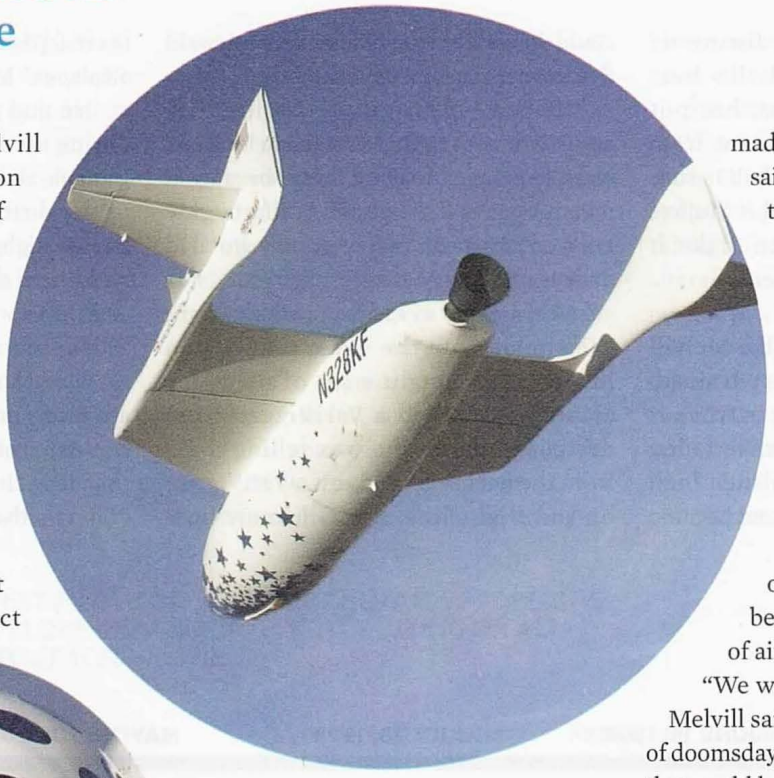
AUGUST 7, 2003

SPACESHIPONE

Melvill flew the first flight of this space-bound aircraft for 24 minutes.

PHOTOS COURTSEY SCALED COMPOSITES, LLC; SECOND FROM LEFT CHAD SLATTERY; FAR RIGHT MIKE MASSEE

Melvill took an active role in each new aircraft design and learned all of them from the ground up.



LEARNING FLIGHT TEST. Melvill did much of the test flying on the Long EZ, as well as all of Rutan's subsequent designs—which included the Beech Starship, Ares ground-attack aircraft, Grizzly STOL airplane, VisionAire Vantage, Williams V-Jet, and Boomerang piston twin.

"Burt showed me how to fly the maneuvers in a way that allowed him to collect the data he needed to perfect the aerodynamics and performance of the aircraft," he said. "The more I did that, the more he trusted me, and the closer we worked together."

Melvill became general manager of Scaled Composites, and Sally was the head of human resources. Together they invested in the company when Rutan assembled a group that essentially took the firm private, buying it from a series of corporate owners. The Melvills' investment paid off when defense giant Northrop-Grumman bought the company in 2007.

Melvill, now 72, is an active general aviation pilot and flies an Extra 300L as a chase pilot for *SpaceShipTwo* flight tests—but he has no intention of flying any more spacecraft. "I made a promise to Sally that I'm done with that," he said. "We've been married 51 years, and the only way you get to do that is by honoring your promises."

Melvill worked closely with Rutan for three decades (Melvill retired from Scaled Composites in 2007), and the two spoke almost daily. A hands-on pragmatist, Melvill was a sounding board for Rutan, and he often was among the first to learn what the visionary designer was thinking.

"He came into my office almost every morning," Melvill said. "He would say something like, 'I think we've developed the technical expertise to build a twin, or a jet.' But I'll never forget the day he said he thought we had the technical expertise to fly an aircraft into space. It was something I'd never considered. We were doing a credible job with airplanes that flew about 200 miles an hour—but to get to space, we'd have to fly at Mach 3. It seemed too ambitious to seriously contemplate, and I was intimidated."

Melvill took an active role in each new aircraft design and learned all of them from the ground up. *White Knight*, the aircraft that was to carry *SpaceShipOne* aloft, was almost identical inside the cockpit to the smaller spacecraft. "They were literally made from the same mold," Melvill said. "The only difference inside is that *White Knight* has throttles and engine instruments. Other than that, they're exactly the same."

Rutan had never designed a supersonic aircraft when Scaled Composites began building *SpaceShipOne*, and many experts doubted the twin tails would survive the resonance that might develop between them at the broad range of airspeeds the craft would travel. "We were confident it would work," Melvill said. "But there was no shortage of doomsday scenarios for all the bad things that could happen if it didn't."

The aircraft was inherently unstable at high speeds, and it required deft pilot handling. On one of its first powered flights, the guidance system failed and Melvill looked out a small side window to stay oriented. On his second space flight, another encounter with high-altitude turbulence caused *SpaceShipOne* to yaw 15 degrees, pitch up 8 degrees, and started a series of 29 snap rolls that began at 160,000 feet and continued all the way out of the atmosphere. Melvill tried to counter the unwanted rolls but realized, "There's just not enough air up there to fix that particular problem."

SpaceShipOne made 17 flights, every one of which redefined what was then known to be possible.

OTHERWORLDLY SOUNDS. *SpaceShipOne* banged into the atmosphere, shaking and rocking as the air beneath it thickened. The air particles were thin and patchy at first, and the spacecraft pitched fore and aft as it encountered them at an ever-increasing speed. Even in its high-drag configuration, *SpaceShipOne* accelerated to Mach 2.9 in the highest reaches of the atmosphere. As it descended, the forces built steadily to 5

Gs, compressing Melvill into his seat. He had to strain to keep the blood flowing to his head and remain conscious as the powerful forces collided. Outside, wind noise and otherworldly sounds increased with an alarming volume and intensity.

"I was not afraid all the way up," he said. "But I was a little afraid on the way down. Boy, when you reenter at 2.9 Mach and you start hitting the atmosphere, the noises you hear are somebody talking to you very, very sharply. You know, you begin to think, *wow, should I be doing this?*"

At an altitude of about 60,000 feet, Melvill reconfigured *SpaceShipOne* as a glider. The streamlined shape allowed him to take control and maneuver the craft with a conventional stick and rudder pedals, providing comfort to the veteran pilot.

Even though *SpaceShipOne* had begun its descent more than 20 miles from the place program engineers had intended, gliding that extra distance was easily done from Melvill's high perch. But the aircraft was out of trim, and Melvill decided to leave it that way. If the trim system had been compromised during ascent, he didn't want to exacerbate the situation by changing it now.

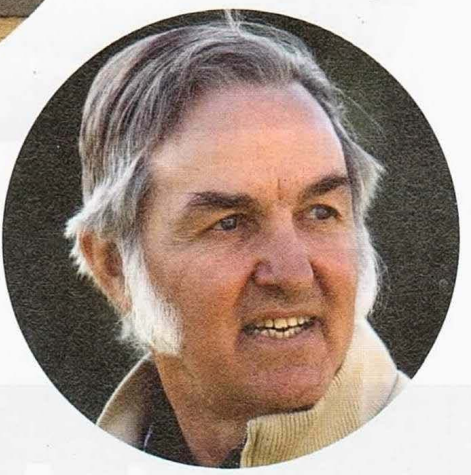
The approach and touchdown on Runway 30 at Mojave went according to plan, and much as the previous unpowered flights had ended. For reasons of lightness and simplicity, *SpaceShipOne* didn't have brakes. Melvill simply rolled to a stop on the nose skid.

More than 25,000 people had come to Mojave to watch the launch, and millions more tuned in on television. Former NASA astronaut Edwin Eugene "Buzz" Aldrin Jr. was there, as well as then-FAA Administrator Marion Blakey.

"I knew there was a high level of interest in the work we had been doing, but I was surprised and deeply touched that so many people came out to wish us well that day," he said. "It meant a great deal to everyone on the Scaled team who had put heart and soul into the project."

Rutan was elated by the success—but also focused on the problems that caused the uncommanded roll, the bang, and the resulting lower altitude (*SpaceShipOne* had been projected to reach 360,000 feet that day), and missing the reentry point. He vowed not to fly again until the problems had been identified and corrected, and the team considered another test flight before starting the clock on the Ansari X-Prize, a $10 million award for the first reusable civilian spacecraft to fly to space twice within a two-week period.

The Scaled Composites team soon discovered the reasons for the roll (wind shear), and made the required trim system adjustments. The bang was caused by the failure of a fairing and quickly remedied. Melvill made another space flight on September 29, and astronaut Brian Binnie—a former U.S. Navy test pilot—made the final rocket-powered flight of *SpaceShipOne* on October 4, 2004, reaching an altitude of 367,442 feet to claim the X-Prize.



Melvill carried *SpaceShipOne* aloft aboard *White Knight* on its final trip to Washington's Dulles International Airport, where it was donated to the Smithsonian Institution National Air and Space Museum; the historic spacecraft now hangs in the museum's Milestones of Flight exhibition on the Mall in downtown Washington, D.C.

Melvill saw it there recently and seems genuinely surprised and gratified by its place of honor. "It's right next to the *Spirit of St. Louis*, the Bell X-1, and the Wright *Flyer*," he said. "And these aren't replicas. They're the real things." **AOPA**

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UNLIKE OTHER spacecraft, *SpaceShipOne* depended on an extraordinary degree of stick-and-rudder pilot skills. In many years of close collaboration, Melvill (top) and designer Burt Rutan (above right) created and tested a stunning variety of pioneering aircraft. In its aerodynamically clean configuration, *SpaceShipOne* was a sleek glider. Its nose (far left) was made in the same mold as the nearly identical cockpit of the *White Knight* carrier airplane.