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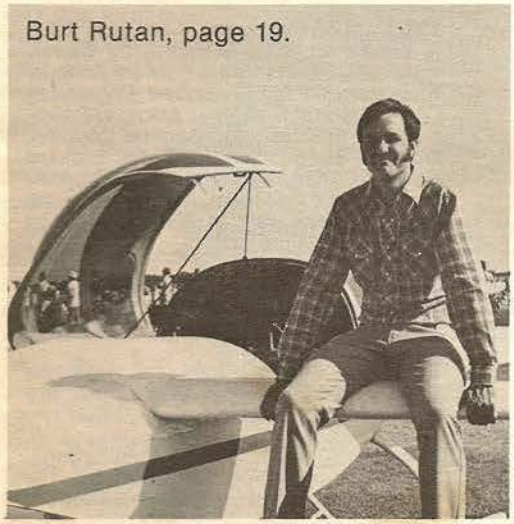
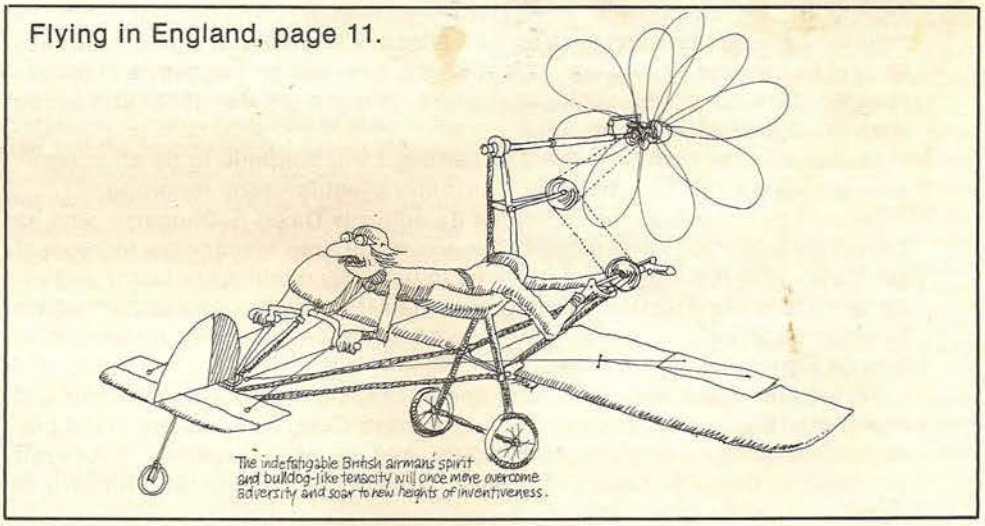
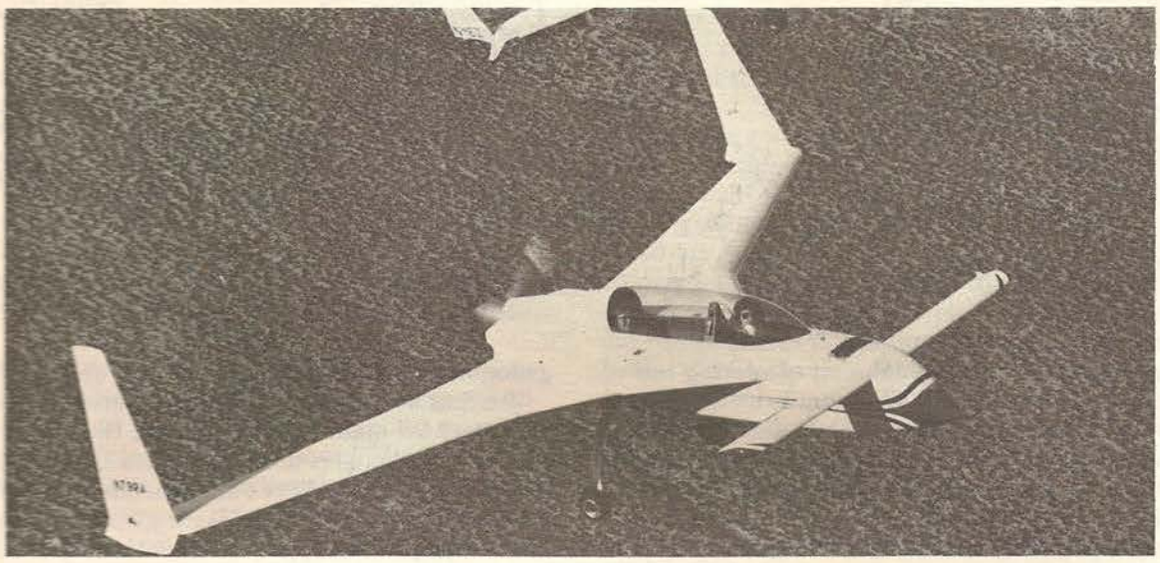




In This Issue

Long-EZ Update

As the homebuilt hordes gather this month in Oshkosh, the Rutan Long-EZ is perhaps the most popular of the build-it-yourself aircraft. Here's an update on its first year in the marketplace.



by Brent Silver

Burt Rutan's VariEze took the homebuilt world by storm in the mid-70s. The radically different canard configuration and foam/glass composite construction helped give it extraordinary cruise efficiency, and the plane was called "unstallable." Thousands of homebuilders ordered plans, and hundreds are now flying. But the VariEze had some serious problems. Roll control was initially rotten. (At slow speeds the stick was ineffective in roll and the pilot had to bank mostly with the rudders.) A series of modifications eventually corrected that problem. In addition, the VariEze is rather cramped, and there is hardly any baggage room. Stall speed is high, and the long, flat approach angle makes for very long takeoff and landing runs. Center of gravity is critical; longitudinal control is twitchy enough at normal c.g., but many builders insisted on ignoring Rutan's advice and installed heavier engines and electrical systems, which put some aircraft beyond their aft c.g. limits. The VariEze was unstable under these conditions, and several accidents occurred—including a couple that looked suspiciously like stall/spins.

The Long-EZ was designed to be a grown-up VariEze that could safely use the popular Lycoming O-235 engine and an electrical system. But the first Long-EZ was a big disappointment. Burt says, "It did not fly well." His brother and test pilot, Dick Rutan, put it a bit more bluntly: "It was a piece of shit."

Rutan tried over 30 modifications to the Long-EZ without completely solving these problems. Finally he decided to completely redesign the wing.

Among the changes: less sweep, more area, a new Eppler airfoil, longer ailerons, and improved winglets. Rutan flew the second Long-EZ prototype and he was well pleased.

The Long and Short of It

Long-EZ plans were first sold in April, 1980. In the following year, more than 1,000 sets of plans were sold at $198.50 each. (For comparison, Cessna made 827 Model 152s in 1980.)

From a distance, the Long-EZ looks pretty much like a VariEze. As you get closer, you can see the differences: much larger wing, larger winglets, and larger wing strakes (which hold the 52 gallons of gas that give the "Long" its name). The Long-EZ is not longer than the VariEze, but it flies a lot farther. In fact, Dick Rutan has set a closed-course distance record of 4,800 statute miles in the Long (*The Aviation Consumer*, March 15, 1980). That's long.

From Vari to Long

Plans for the VariEze were first sold to homebuilders in July, 1976. The great success of the VariEze helped lead to its demise. The preferred engine for the VariEze was the Continental O-200, but that engine ceased production when Cessna switched to the Lycoming O-235 for the 152 in 1977. VariEze builders were bidding against each other for the remaining O-200 engines.

Besides that, the builders were adding electrical systems and starters to the VariEze. This was weight that Rutan had not planned on. The result was that many VariEzes turned out tail-heavy. That degraded the flying qualities, which were already a bit squirrelly. The alternative was to add nose ballast, but that aggravated the weight problem. What to do? Design the Long-EZ to:

- Accept the heavier Lycoming O-235 *and* a full electrical system;

• Raise the gross weight so that two people could fly, with enough fuel to cover long distances;

• Increase the wing area to carry the added weight and to improve low speed characteristics;

• Improve the handling qualities.

Aircraft Comparison

The Long-EZ appears to have achieved its design goals. However, the VariEze, being smaller, retains the edge in speed and miles-per-gallon efficiency.

The Long-EZ has an aspect ratio (8.3) that is higher than most production airplanes. These long, graceful wings help explain the airplane's efficiency. In terms of miles-per-gallon, the Long-EZ just about doubles the fuel efficiency of the typical factory-built two-seaters like the 152 and Tomahawk.

The Rutan efficiency comes from low drag. There are several reasons for this. One is the high aspect-ratio wings. Another is the super-smooth skin of the fiberglass construction. The smooth skin, combined with the aft placement of the prop, means more laminar flow. Finally, Rutan just paid a lot of attention to details, such as how the winglets fair into the wings.

The net result is that the VariEze has an equivalent flat-plate drag area of about 1.4 sq.ft., and the Long-EZ is only somewhat higher, perhaps 1.9 sq.ft. To give you some intuition for this achievement, an opened copy of *The Aviation Consumer* has a flat plate are of 1.3 sq.ft. It would take about the same force to push a VariEze through the air as a flat plate the size of this magazine.

Workmanship Critical

An airplane with the small drag area of Rutan's designs is particularly sensitive to workmanship, and to added geegaws. That helps explain why the typical homebuilt VariEze does not have the performance of Rutan's prototype. Rutan readily admits that the average VariEze falls short of his book performance figures by about eight percent. Customer-built Long-EZs will also be somewhat heavier than the prototype, but performance should match or exceed the "draggy" Long-EZ prototype, according to Rutan.

Fiddled Numbers

Even though we fiddled Rutan's weight numbers a bit, it is still clear that his airplanes run away from production aircraft in speed, rate of climb, and efficiency. Let's state it flatly: there are no production aircraft, of similar power, that match Rutan's homebuilts in terms of speed and efficiency.

But don't overlook the airport end of the flight. Even Rutan's airplanes still have to take off and land. Here is where the spam can beats the glass slipper. In and out over a 50-foot obstacle, a Cessna 152 beats the Long-EZ by about 700 feet. That may be okay if you deal only in longish runways, but the fact is that Rutan's airplanes are runway gobblers.

Even with the optional landing brake extended, the landing distance over a 50-foot obstacle is about 2,100 feet for the Long-EZ. Without the landing brake (Rutan's prototype, which we flew, does not have one), you will feel like carrying an anchor to throw out as you float down the runway.

Rutan's advice is this: "Neither the VariEze nor the Long-EZ is suited to unprepared fields, soft surfaces, gravel or small airports (less than 2,000 feet, or 2,400 feet with obstacles)." Since this statement was made, a landing gear has been designed for rough fields; however, the caution about short fields still applies.

"Traveling Machine"

Rutan calls the Long-EZ a "traveling machine." It does cover distances between good airports with speed and efficiency. The table lists the range as 1,400 nm for the Long. That assumes a 360-pound payload (two standard people) and 42½ gallons of gas, to give the special-condition takeoff weight of 1,425 pounds. It should be noted that the 1,400 nm is obtained at the 40 percent power setting (127 knots).

With only the pilot aboard, the Long really gets legs. For example, the Long-EZ could fly one person from Dallas to Buffalo (1,040 nm at 161 knots) in under seven hours nonstop. There would be four gallons in the tanks at arrival.

Fuel System

But would you land an airplane with only four gallons in the tanks? Considering the amount of unusable fuel and the inaccuracy of gauges in most airplanes, such a move would be foolish. But it can be done safely in the Long-EZ. Here's how: First, there is almost *no* unusable fuel—at worst, maybe "a half a cup in each tank." Rutan accomplished this by building small sumps under each tank. Secondly, the fuel gauges are just clear strips that allow you to see into each fuel tank. Rutan co-worker Mike Melvill says, "If you see gas in the tank, it is there; if you can't see gas, you should land."

Safety

Rutan is sincerely concerned about safety. In addition to the fuel system, this concern shows up in the aerodynamic design, which is intended to be unstallable, and in the structure, which is intended to be over-strength.

What is the accident record of the Vari-Eze? An article in *The Aviation Consumer* (July 1, 1980) summarized the accident record of homebuilt aircraft. The results for the VariEze? Mediocre. For the three years from 1976 through 1978, the Eze had five accidents, three fatal. On a per-100 registered aircraft basis, the VariEze accident rate was 2.59 (1.55 fatal). Average for homebuilt aircraft was 3.93 (1.07 fatal).

Burt admits disappointment in the accident record so far, but feels it should get better, particularly with the Long-EZ. Rutan is also proud of the

(Continued on page 18)

The first prototype Long-EZ was a disaster. *Note "Rhino" rudder and mid-span fins, added to solve handling problems. Aircraft was completely redesigned before being offered to builders.*

Flying the Long-EZ

Rutan Aircraft Factory (RAF) is located at the Mojave Airport, just a mirage away from the fabled Edwards Air Force Base. I arrived at Mojave in a rented Cessna 172. Unicom suggested Runway 7, a 6,000-foot strip with the first turnoff halfway down. After landing, I added power to taxi to this turnoff. I would remember that later in the Long-EZ as I floated by mid-field in my solo landing attempt.

I taxied up to Hangar 13, home of "RAF," and shut down. As I walked toward the hangar I heard an angry little whine overhead, and looked up to see a Long-EZ making a high-speed pass over the Rutan ramp. Traffic pattern? What traffic pattern? This here is the wild west, pardner.

The pilot of the Long-EZ, I discovered, was Dick Rutan, Burt's brother. Dick invited me for a ride. I belted into the back seat; Dick remained in the front. He motioned to the headphones and I put them on. Over the intercom (a great boon in this tandem-seat aircraft) he explained the controls I would have in the back seat: the sidestick controller, but no rudder pedals and no throttle.

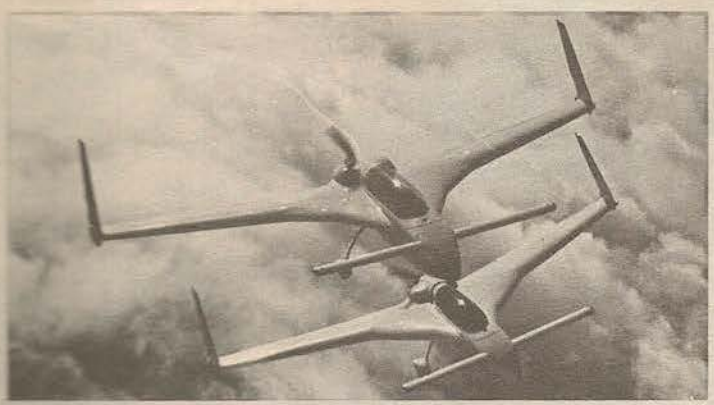
The back seat is reasonably comfortable, although my feet kept searching for rudder pedals—or at least some kind of foot rest. Headroom is adequate but not excessive. Visibility upwards and to either side was great; but over the nose, forget it. I felt like I was in the back end of a long bathtub, with my eyes just above the edge.

Taxi ride and takeoff were a bit bumpy (the main wheels are small and carry 80 psi). Dick climbed to altitude and showed me some nice crisp rolls, followed by a loop. Over the intercom, I casually inquired as to the strength of the aircraft. I hope it sounded casual. Dick said the airplane was good to 12 g's, but that we were only pulling 4 g's at the moment. That sounds like enough.

(A note here for others tempted to emulate Dick with aerobatics in the Long-EZ: the manual says "no aerobatics." Burt later explained, "We don't want our builders to do aerobatics. The record of homebuilt aerobatics is horrifying.")

Dick reluctantly told me to fly. I demonstrated a maneuver that is evidently new to Dick. It is called "straight and level," and it is one of my favorites after five minutes of aerobatics.

The instruments are in the front cockpit only and are hard to see from the back. I asked Dick to give me some readings for a speed check. With a weight about 100 pounds below gross, we trued at 158 knots. Power was at 2800 rpm, which was about 85 percent. That speed agreed with Rutan's published data.



Looking like a pair of mating dragonflies, *the first two Long-EZs built fly formation over the Mohave desert.*

Next, we tried out the slow-flight characteristics. As speed decreased, it was easier to excite the Dutch-roll mode. At minimum speed, it was interesting to watch the canard shake (it was partially stalled). I held the stick full back without getting any nose drop or tendency to roll-off. Dick added power and we climbed out with the stick full back.

Dick suggested that we go back to the airport and switch seats. I entered a low left downwind and Dick controlled speed with the throttle. As I rolled out on final, the runway disappeared. The long nose of the airplane blocked my view. "I can't see the runway," I calmly announced. "That's okay," Dick answered, "if you can see it, you're not lined up." There was something about his answer that did not fully satisfy me. "You've got it," I declared.

Back on the ground, Dick and I traded seats. The view from the front seat is superb. The semi-reclining seat is comfortable and would easily accommodate a tall pilot (Burt is 6'3"). At 5'10" I required an extra cushion to bring my eye level up to the optimum.

Steering is through differential braking. The brakes are actuated through the rudder pedals and only take hold after a rudder has gone full travel. My first light stabs at the pedals helped the airplane describe a random-walk path toward the taxiway. I soon found the knack of depressing both rudder pedals down to the point where each brake was barely

Specifications and Performance

Engine	108-hp Lycoming O-235
Gross weight	1325 pounds*
Empty weight	810 pounds
Useful load	515 pounds
Cruise speed	161 knots
Minimum speed	55 knots
Maximum speed	167 knots
Fuel capacity	52 gallons
Maximum range (360 lb payload)	1400 nm
Miles per gallon	33 nmpg
Rate of climb	1,200 fpm
Service ceiling	17,000 feet
Takeoff over 50 foot obstacle	1,800 feet
Landing over 50 foot obstacle	2,100 feet
Length	16.8 feet
Wing span	26.1 feet
Wing area (total)	94.8 square feet
Main wing aspect ratio	8.3
Wing loading	14.0 pounds per square foot
Power loading	12.3 pounds per hp
Homebuilding time	1,300 hours
Equipped price	$12,000

**Homebuilders will find a wide variation in actual weights, performance, cost and building times. Values shown are believed to be representative.*

touched. This smoothed out the taxi steering but Dick cautioned me not to keep both pedals depressed during takeoff or in flight (they act as small drag brakes).

Takeoff

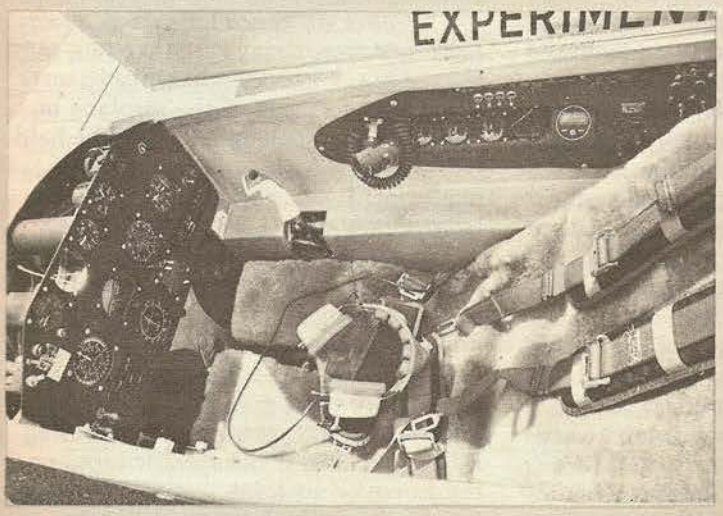
Takeoff rotation was at 60 knots and I was careful to hold the canard below the horizon. Speed built rapidly and I eased the airplane into a 1,000-fpm climb at 105 knots. Dick suggested that I sample the rate of climb over a wide range of airspeeds. Climb rate appeared relatively insensitive to speed. We still indicated 1000-plus fpm at 65 knots.

We shot a series of touch-and-goes until Dick suggested that I let him out. Taxiing out, I reflected on the fact that there were only two Long-EZs flying in the world (at that time). I wondered at Rutan's judgment in releasing the airplane to a stranger (me). Later I found out that I was the 42nd person to fly from the front seat, and many of these were solo. (Considering the limitations of the back seat, even if it is occupied, the pilot in front is almost solo.) Rutan obviously has confidence in his design to allow it to be so promiscuously flown.

I lined up with the runway and advanced the tiny throttle lever. The small, light controls make you think you are flying a toy airplane—and maybe you are. I flew off the runway with barely a bobble. Several people have had trouble on their first takeoff in the VariEze. Even though the stick forces have been increased in the Long-EZ, they are still light. The trick is to use the wrist to control the side stick, rather than the bicep as we are used to with a conventional control (wheel or center stick).

Rutan suggests that people check out in a variety of aircraft before they attempt to fly the Long-EZ. An airplane with light controls, like the Yankee, would be appropriate. I suggest you fly the Yankee from the right seat so that you can get used to flying with your right hand. (Take an instructor in the left seat.)

I felt a special moment as the Long-EZ lifted off the runway. It reminded me of the surge I felt when I first soloed. At this light weight (low fuel and one aboard), the airplane climbed quickly up from the desert floor. Before long, I pushed over to make a strafing run on a particularly sinister clump of sagebrush. I hit the intercom button and pickled off my entire load of rockets. That's one sagebrush that will never threaten America again.



The first homebuilt Long-EZ, *constructed by John C. Murphy Jr. in eight months at a cost of $12,000. Powerplant is a 125-hp Lycoming. Murphy is a NASA engineer at Cape Canaveral and mayor of the town of Cape Canaveral* Howard Levy Photo

Cockpit of Dick Rutan's 160-hp Long-EZ, *in which he recently completed a record 4,500-mile flight from Alaska to the Caribbean.*

With some alarm I noted I had allowed the rpms to nudge beyond the redline of 3,000. (Burt later told me not to worry, the low-inertia prop allows higher rpms without overstressing the engine.) I throttled back and tried to reign in my enthusiasm. Now what was I supposed to be doing here? ("Base to Walter Mitty. Come in, Mitty.")

Back at altitude, I tried some stability checks. N79RA is spirally stable to the right, but not to the left. If trimmed to 90 knots and pushed over to 110 knots, the airplane will return to 90 knots after control release (speed stability is okay). The phugoid is damped, as is the short-period mode. You can pick up a wing with rudder, but rudder power seemed limited.

Landing

"Be back in 45 minutes," Dick had told me (or you will run out of gas, he might have added). That was the string Rutan used to keep me from flying away with his airplane. My time was up too soon and I headed back. Dick Rutan was waiting on the ramp and I wanted to make the landing a greaser (Mistake No. 1). I lined up on a long final and locked the speed at 65 knots. I was low (i.e., just right for this low-drag airplane). N79RA has no speed brake. I didn't quite trust my altitude judgment in this airplane and I flared high (Mistake No. 2). I held the airplane in a landing attitude and waited. And waited. (Mistake No. 3). By this time the airplane had slowed a bit and it started wallowing slightly. Was this wing-rock or Dutch-roll? I added a smidge of power and flew the airplane onto the runway. This ground-effect machine and I had floated 3,000 feet. Luckily there was another 3,000 feet left.

If you are still in suspense, the landing was uneventful, if long. It was almost a greaser, but out of sight of Dick, who critiqued my landing effort thus: "Don't you remember I said to just fly it on? Fly it on—don't try for a full-stall Cessna landing." Concerning my supposed wing-rock, Dick charitably suggested it was a PIO, a pilot induced oscillation.

To sum up my impressions: the Long-EZ is *fun* to fly, but it sure doesn't fly like the Cessna 172. (Two out of two ain't bad.)

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fact that his airplanes have never had an inflight airframe failure (in spite of six flutter incidents due to improperly balanced elevators), and that there have been no fuel fires after crashing.

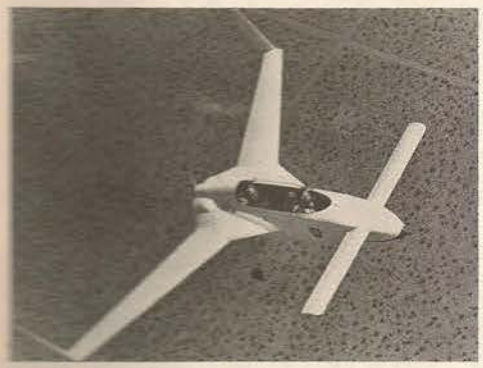
Some people have expressed concern about the crashworthiness of the Long-EZ. To begin with, the engine is behind you instead of in front of you. In the Long-EZ, the pilot is just about first to the scene of the accident. In a conventional aircraft, the engine gets there a millisecond earlier. Rutan says, though, that the engine has come through the rather strong wing-box of an Eze in only one accident, and that was an otherwise unsurvivable, near-vertical dive into the ground (witnesses reported no attempt to pull out; Rutan suspects pilot incapacitation, or control system disconnect).

Rutan also says the foam in the composite construction helps absorb a lot of impact energy. That is a plus for crashworthiness. But the pilot position (and the limited crush depth under his seat) are minuses. In one case, a VariEze pilot was speared by a nosewheel part in a crash. The design was changed in the Long-EZ.

Rutan does deserve credit for describing each accident in the quarterly newsletter he sends to builders ("Canard Pusher," $6.75 per year). He also spends an inordinate amount of time preaching safety to his builders.

Composite Structure

Workmanship is very important on any airplane, but few homebuilders have any background in composite construction. Rutan comments, "I have to admit that it has taken an awful lot of courage to ask a guy to build an all-composite airplane in his basement with no experience, when Beech and Piper and Cessna aren't willing to do that in a factory with white gloves and white coats—yet."



This is the Long-EZ's distant ancestor, *the VW-powered prototype Vari-Eze, which first flew in 1975.*

Composites are relatively new for aircraft. There are many variables in composite selection, design, and fabrication; it is obviously possible to do a bad job with composites. Rutan has tried to be very careful and has built a large safety factor into his designs. The official line is that the Long-EZ is a 5-g airplane. But to account for variation in workmanship and other parameters beyond his control, Rutan has designed what may be a 12-g airplane (when properly built).

There are conditions that could eat away this safety margin (and more). First off, the airplane must be painted (otherwise it will suffer damage from ultraviolet light), and not with just any paint. Have you ever wondered why all the VariEzes are painted white?

Icarus

The epoxy used in the Long-EZ begins to soften and lose strength as the temperature increases. (This is true of all plastics.) At a certain temperature above its cure temperature, this loss of strength becomes noticeable. Rutan's airplanes are (or should be) painted white so that they will not heat up while sitting under the hot sun.

Rember Icarus? He flew too close to the sun, and the wax (which held his wings on) melted. Sound familiar? Rutan says to relax. If painted white, his airplanes' wax (or epoxy, if you will) will not get hot enough to be a problem. Experts we talked to seem to agree. Still, paint it white, OK?

There are other problems with composite construction, and some potential problems that might not surface for years. One of the problems discovered by builders early on was the toxicity of the epoxy used in the VariEze and Long-EZ. Many builders developed a skin rash that developed as one became sensitized by the epoxy, and some had to give up their projects. This problem has greatly decreased since Rutan switched to "Saf-T-Poxy," a low-toxicity epoxy.

All problems considered, it does seem likely that composites will play a very important role in future aircraft construction. Rutan feels that if we had 50 or so years experience with composites in aircraft—instead of aluminum—the FAA would now be reluctant to certify an aluminum aircraft.

Cost and Building Time

The actual cost and building time varies greatly. Rutan says the "competent builder" can put one together in as little as 800 hours. Few will meet this goal. Even Mike and Sally Melvill, professional plane builders and Rutan employees, needed 1,270 hours. One builder we talked to had 2,000 hours into a VariEze and couldn't predict when he would finish.

The cost is only slightly more straightforward. Aircraft Spruce and Specialty Co. sells the total kit for the Long-EZ for $3,282.32. However, you might want to buy some additional prefabricated parts, like the engine mount ($150) and wheels ($240), etc. Then there is the engine (a few thousand dollars). It adds up. For the Melvills, it added up to $13,000.

If you are seriously considering a homebuilt, you might also ask yourself what your spare time is worth. Suppose you think your time is worth $10 per hour and that it will take you 1,300 hours to build a Long-EZ. That's $13,000 that you can mentally add to the cost. If the parts are $12,000, then your total is $25,000. If that still sounds good, consider that maybe 70 percent of the builders will not finish. What does that do to your cost estimate?

Finally, how about this consideration: what do you do with the airplane after you build it? Do you really want to fly it that much? Selling it presents some sticky legal problems. Rutan makes the following caution: "The builder of a homebuilt should seriously consider the liability aspects before selling his aircraft. Since he is an aircraft manufacturer, today's legal system may charge him with strict liability in tort. What this means is, if the airplane he builds injures someone, he may be held liable even if he is not proven to be negligent! It is surprising what a lawyer may dream up ... We at RAF would never sell any of our experimental aircraft. Both the VariViggen prototype and the VariEze prototype were donated to the EAA Museum."

If you are one of those optimists who can look at these considerable obstacles and smile, then perhaps homebuilding is for you. And if the specifications on the Long-EZ look interesting, then maybe this is the homebuilt for you. But we keep thinking of a sign on Rutan's wall: "In regard to Murphy's Law—Murphy was an optimist." □