BURT RUTAN

Different by design

Airplanes used to be designed by individuals. Today they are committee creations. The VariViggen, VariEze, Long-EZ, and Defiant are exceptions. All are the product of E. L. (Burt) Rutan, who has become America's best-known airplane designer through his use of unconventional structures fashioned from unusual materials: bolts of synthetic cloth, blocks of blue-colored foam, and pots of resin. His airplanes are fascinating studies in the maxim that form follows function. Rutan's fertile imagination and disdain for convention have taken shape in strange-looking machines intended for homebuilders, but he also is given major credit for the Beech Starship design.

Rutan's fame spread outside the aviation community in December 1986 when Voyager, which he designed and built, completed a successful nonstop, unrefueled journey around the world with older brother Dick and Jeana Yeager at the controls. The flight was a highly risky but dramatic statement of the potential of high strength-to-weight-ratio composite structural materials. On a more personal level, it was a testament to the designer's ingenuity and intellectual courage.

These days Rutan is staying very busy designing and building experimental prototype aircraft at Scaled Composites, Incorporated, a skunkworks founded by Rutan and partner Herb Iversen at Mojave Airport in the Southern California high desert. After Scaled designed and built an 85-percent-scale proof-of-concept Starship, Beech bought the company. Rutan has continued as president and chief of design and inspiration.

Projects currently taking shape in Scaled's complex include prototypes for a tandem-wing military troop transport; an Unlimited-class pylon racer to compete in the Reno National Air Races; a fanjet-powered cabin-class twin; a close air support military fighter; a five-place, 240-knot, piston-powered single called the Catbird; a carbon-fiber wing for a commercial satellite rocket booster to be launched from a B–52; and a 90-foot-tall, carbon-fiber/Nomex-honeycomb rigid sail for Stars and Stripes, *the 60-foot catamaran that will defend international challenges to United States possession of the America's Cup.*

We visited Rutan at Scaled Composites to find out more about his potpourri of projects and to ask his thoughts about general aviation.

—Mark R. Twombly

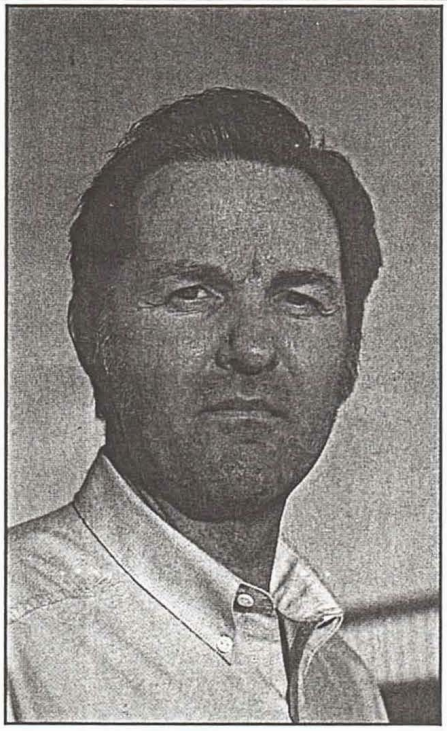
AOPA PILOT: *The wing, or hard sail, that Scaled Composites has built for* Stars and Stripes *is your first major nonaviation effort, and certainly must be your most unusual project ever. Has a hard sail been tried before?*

RUTAN: Yes, with a small version, only a quarter of this size. In fact, the original designers of this configuration, Dave Hubbard and Duncan McLean, have been sailing hard sails somewhat like this for 10 years. This configuration, its flap arrangement and airfoils, was designed by our aerodynamicist, John Roncz, who does all of our airfoil work.

Does he sail?
No.

How did you get involved in this project?
A manufacturer of some high-tech thermoplastic material bound and determined to get its product on *Stars and Stripes* knew that probably we were the only ones who could do it quickly. They came to us and brought the designers of *Stars and Stripes* to look at our shop, trying to get us to build the hulls out of their materials. We pointed out that where we can help the most is in the sail, or wing, so very quickly we convinced them that we should design and build the wing.

They had already decided to do a wing?
Oh yes. In fact, they were going to build it out of plywood.



Tell us about the Catbird.
It's a five-place airplane [that has] only two thirds the wetted area of your Mooney out there. Did you bring in that Mooney? What is that, a 201? I was going to say if it was a 252 we'll go out and have a race. This thing here goes 240 knots. It's pretty impressive. The engine is a 210-horsepower, four-cylinder Lycoming [TSIO-360]. This airplane has coast-to-coast range. This is probably the highest-tech general aviation wing in the country, the latest work on the pressure distribution and on the planform and some details on how it flows into the fuselage to reduce the fuselage drag.

Is this John Roncz's work also?
Yes, this is a Roncz airfoil.

What is the fuel capacity?
It's just under 80 gallons.

Does the Catbird have cowl flaps?
This is the thing that is really very nice on this airplane. We have an adjustable inlet ramp. So you have a big hole for cooling air on climb, and then when you bring the power back for descent you can close the inlet and keep the engine warm. The outlet is similiar to the one on the Defiant. It's not adjustable. It has the same drag essentially whether there is a lot of flow or a little bit of flow.

How is it for passengers in the Catbird? Tight?
It's great. The back-seaters are usually the most uncomfortable in any general aviation airplane. They have to yell at other passengers to be heard, and there is no good place to put their feet or knees. In the Catbird, rear-seat passengers are turned around. They have

a 46-inch-wide cabin, which is wider than what you flew in here by about an inch or so. They can stretch their feet all the way out in the tailcone—gobs of room. It's super comfortable. The pilot's seat, of course, is the best seat in the house. That's why we call it the Catbird, because the pilot is sitting in the catbird seat. I like to have the arm supported—we have autopilots because you can't hold your arm up for four hours—so in the Catbird you have an armrest near the stick. You're up a little bit higher than everyone else. You have absolutely symmetrical visual cues so when you roll right or left you have the same visibility. The cabin roof shades the pilot from the sun. I tell you the view out of this thing, it's mind-boggling: . . . the little sticker of canard out there is a visual reference, it has a flat wing, and there are no corner posts or anything.

The widest part of a person is at the elbows. For some reason airplane designers put the elbows of two people at the same fuselage station on the same water line. That's absolutely the worst thing you can do. Now if I stagger the middle seats just 13 inches, now we are comfortable. We are actually closer together for communication than we were sitting side by side.

How do you get in the airplane?
The canopy is hinged at the front and opens forward. The pilot's seat folds forward and pilot and middle-seat passengers step right in. This is a pressurized airplane, so it has a plug door on the right side of the rear cabin. That looks like a baggage door, but it's the door for the back-seat passengers.

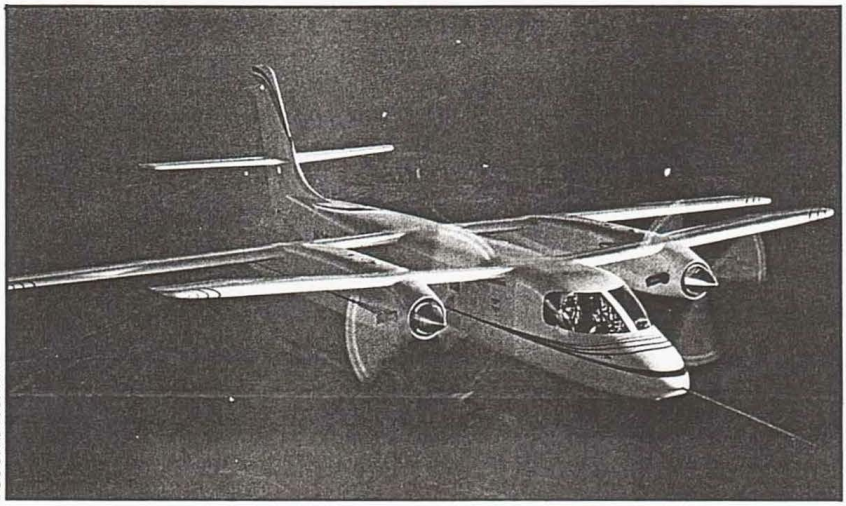
Are you getting the speed out of it?
We get 2,000 feet per minute climb to 17,000 feet, the critical altitude. I don't know what the rate of climb is up at 25,000, but it is still pretty healthy. We have recorded data as high as 265 mph [230 knots]. The engine/prop combination is limited to no more than 34 inches below 2,300 rpm. At 30 inches throttle and 1,800 rpm it's not real fast, 196 mph [170 knots], but at 7.3 gallons per hour it will give us about 11 hours of endurance.

This is your second airplane with a canard, main wing, and horizontal stabilizer. Is this an optimum configuration?
There's no such thing as an optimum configuration. Every airplane has different considerations. We have a third surface on this airplane [the canard] for stall characteristic improvement. It also lets me put the spar back behind the passengers between the first and second rows. I don't like to sit on top of a spar where you don't have any crush protection in a crash. If you put a wing on the bottom, you're going to have interference drag. Notice this wing is not right on the bottom. It's up higher on the fuselage. This is a five-place airplane, but it's got a significantly lower drag than the two-place, tandem-seat Long-EZ. Of course, the Long-EZ has fixed gear. The Catbird's wing tips are upturned for dihedral effect because I didn't put enough dihedral in the wings. That's a change we made after we flew.

Do you have the option of selling the Catbird to another manufacturer?
No, I don't have the option of going out and working with Piper or someone. Certainly not. It wouldn't be proper even if Beech isn't emphasizing airplanes in that class. Certainly Beech is interested in the Catbird data. It was

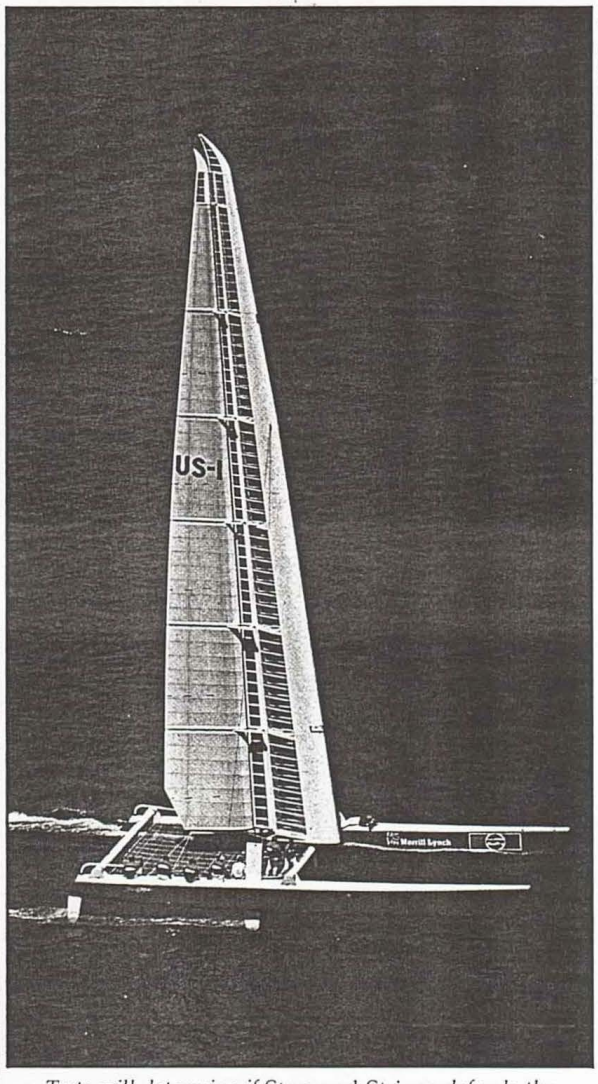
DOUGLAS B. SHANE

Beech acquired the Catbird when it bought Scaled Composites, but Rutan has since bought back the rights. The Catbird won the 1988 Comparative Aircraft Flight Efficiency (CAFE) race with a record score. Rutan has no plans to sell plans or kits.



DOUGLAS B. SHANE

Scaled Composites designed, built, and is testing a 62-percent-scale version of an unusual tandem-wing Advanced Tactical Troop Transport for the U.S. Army. The airplane is intended to operate out of short, rough fields and fly for long distances.



BOB GRIESER-ALLSPORT USA

Tests will determine if Stars and Stripes *defends the America's Cup with a conventional soft sail or Scaled Composites' rigid, carbon-fiber/Nomex-honeycomb "wing" sail. Movable flaps alter camber of the sail to adjust for wind conditions. Sail area can be changed at the dock.*

a budget crunch really that got them out of the project. I ended up with the airplane, and I will be sharing the data with them. I'm concerned because of the product liability situation about getting into general aviation by selling rights to designs. I did that from 1974 to 1985 and finally concluded that the risks were not commensurate with the income.

I think there is a way to handle the product liability situation. Jim Walsh [James S. Walsh, former president and chief executive officer of Beech Aircraft] came up with it. I think it would work, particularly for a new company. Product liability insurance is such a severe hit now because in the past, nothing was put in the bank for liability when an airplane was built. Let's say, for example, the Beech 18 is a big liability concern because the airplanes are so old. What if, when each Beech 18 was built, the company had put aside six percent of the price of the airplane into a money market account, let it grow, and drew out of it only to pay liability-associated costs? Today, 30 years later, not only would you have the money to cover liability costs, now you could go out and buy all the airplanes and cut them up to remove the liability. Okay, that approach doesn't help Piper and it doesn't help Beech, but presumably a new company could do it. It's just simple arithmetic. Put the money in when you sell the airplane. As bad as our litigious society is right now, all we're talking about is six percent of the price of the new airplane.

What interests you in the way of new engine technology?

Electramotive, Incorporated, the outfit we are dealing with on the engine for the Pond Racer, is a small company, 30 employees or so. It's a specialized engine for racing, and it has a box in it about the size of a large book. When you get done with a race, you can hook it up to your Macintosh computer and spread time histories of all the engine parameters recorded during the race and plot them against each other. Say you call up the timing curve. It jumps up on the computer screen as a plot of timing advance versus rpm. You look at that, take the little mouse and move the curve down to high rpms, and say "Let's try that." You push the Enter button on the computer, and now the engine behaves according to that relationship. Wow! Simplicity to me is high technology. If you've spent $10 million writing software for fly-by-wire, I don't call that high technology. The Electramotive package is kind of neat for a light airplane. I could take this package and design an airplane to it. You wouldn't run it at 1,000 horsepower, but at 400 or 500 hp it is a very reliable engine. It's very smooth, it has the very latest technology, and its combustion design is just eloquent.

Does the Pond Racer borrow some of the technology used in Voyager, *in this case the configuration technology?*

Yes, the basic configuration, the way we

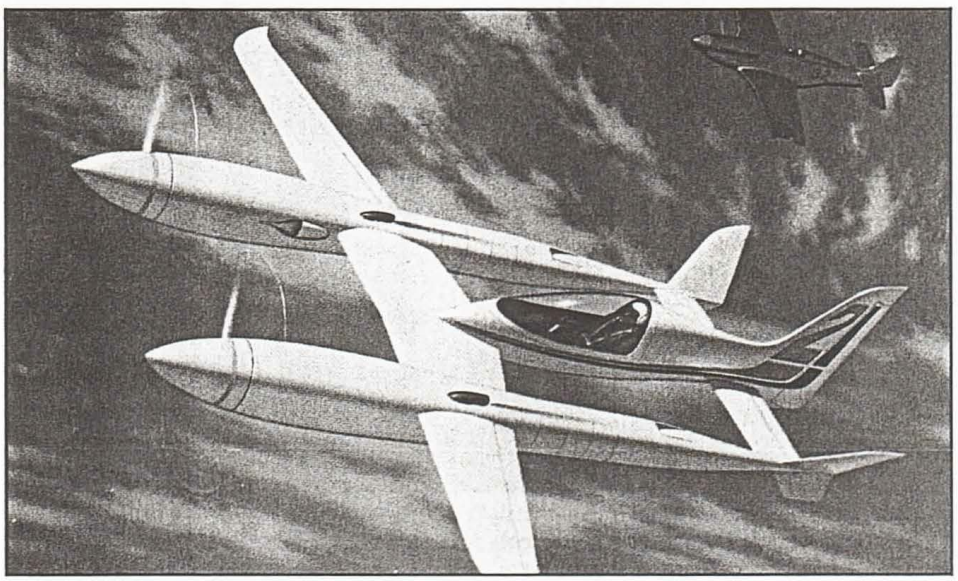
brace the fuselage. In *Voyager* we were bracing these big, heavy fuel tank booms with a canard. Here we are bracing these big, heavy engines in much the same way with the tail. It's a lot like *Voyager* flying backwards. To be honest, I wasn't even thinking of *Voyager* when I laid out the Pond Racer.

Can you talk about the philosophy behind the configuration of the ATTT?
The special mission utility transport (SMUT), which was our acronym but the customer insisted we use a different one, had a requirement for very long range. Which means two things. One is long, slender, high-aspect-ratio wings of the *Voyager* type. But then there's not enough room in the wings for fuel. I couldn't put the fuel in the fuselage because of the crash situation—it's supposed to carry troops. I didn't want the landing gear in the fuselage because the airplane is supposed to operate out of unprepared strips and the gear needs a big stroke. I didn't want the drag of big gear-well bumps on the fuselage, so I ended up trying to blend engine, landing gear, and fuel into one big, smooth, low-drag pod. Now, if I had put that pod on a single wing, the landing loads, gyroscopic loads, and the inertial loads of all of this fuel, landing gear, and whatever would twist the wing. And slender wings are not very stiff torsionally. So the configuration of two wings to brace this big pod structurally made sense. Can you make a configuration like that as efficient as a single-wing airplane? The answer is no, but you can come relatively close and still have the benefit of the structural bracing. Now we may make an interesting configuration change: Cut off the tail, just make a tail on the back of the fuselage that would open up to drive vehicles into it.

I see the proof-of-concept Starship is hanging from the rafters in Scaled Composite's hangar. Is its work finished?
We finished flying it about two years ago. The airplane originally was built for a 50-flight program to develop flying qualities and performance. It completed its first 100 hours of flying in only 35 days. It went on to fly for two and a half years and put in 540 hours of testing. We ended up doing just about everything with the airplane. We put pressure belts all over it to measure pressure distribution to assist in determination of the loads for the certification program. We put ugly shapes all over the leading edges to simulate ice buildups to see how the airplane would fly. We ran it through standing water pools on the runway to look at water splash. We tested a whole bunch of modifications. We tested a bunch of failure modes—all the flaps down on one side and all of them up on the other side. We even tested three relief tube locations on the bottom of the fuselage to ensure that when you flush the toilet, it didn't go into the wheel well. We tested the environmental control system. We built new engine nacelles and flew the airplane with full-scale engines. We did quite a bit in two and a half years. We did a lot of structural dynamic work to support full scale [development].

What will its fate be?
I wanted to use it as a chaseplane here since we found its maintenance was almost nothing compared to the rental chaseplane we were using, but there was some pressure to try to get it into a museum. There still may be. Right now it provides inspiration for the builders here at Scaled. It hangs up over their heads and looks pretty. I don't know what we'll do with it.

There has been time for things to settle down following the Voyager *flight and for people to take the long view of it. What do you believe has come out of it in terms of the technology fallout and also people's conception of an unusual airplane built of unusual materials? Has it made a difference?*
It's interesting. You ask a schoolchild what *Voyager* looks like and he'll take a pencil and draw it for you. That, I think, is significant.



The 3,000-pound, 2,000-horsepower Pond Racer should be capable of nearly 600 mph (521 knots) and could end domination of pylon racing by modified World War II fighters.

There are not too many airplane configurations a schoolchild will be able to draw. This is what really blew me away about *Voyager*. I would not have guessed the impact on the nonflying public. It was a beautiful news event. No question we suspected this before the flight, but we didn't have any idea that it would have been popularly covered and understood and followed the world around. Actually it was covered even more in Europe and Japan than it was here.

Do you think the airplane has made a difference in the way aircraft designers think?
I think the inspiration comes from looking at this very simple, very eloquent, lightweight, all-carbon structure. If it can be built in this little shop and fly around the world, that's telling you something. While *Voyager* didn't identify new materials or new processes or new design methods, it was a simple, low-cost, high-performance structure, and dog-gone it, if we can do other programs, from a general aviation airplane to an F–15, with those philosophies and approaches, we're going to have efficient structures. We used roughly the same materials on the America's Cup sailboat that we did in *Voyager*, and we'll use very similiar structures in the wing for the satellite booster rocket and in the Pond Unlimited-class pylon racing airplane.

Will your future involvement in general aviation be directed at airplanes for the masses?
I still have this leftover desire, or feeling, about a better general aviation airplane. In the long run I do want to do a couple of general aviation airplanes, certainly an entry-level one, because I've identified some neat manufacturing methods. It could be a dramatically improved airplane over what we have. We have to keep our roots in mind. If we don't have 150s to train pilots, what's going to happen to general aviation 20 or 30 years down the road? Attracting somebody into aviation with a Cessna 150, when he drives to the airport in his Porsche, is absolutely absurd. So we're going to have to have modern cockpits, and I think it's absurd to think that we're going to re-equip 30-, 40-year-old Cessna 150s and have a modern cockpit. The answer is that we've got to have a modern entry-level trainer. Absolutely have to have it. And it has to be a blend of a modern cockpit as well as a new-technology engine. I want to be part of that challenge because I've got some ideas that I'd like to express. I'm not working on it right now because I'm very happy and completely tied up doing some other things, but I have a feeling that I'll eventually want to do that. I also want to do an airplane in the Defiant or the Catbird class. Having that kind of performance and that kind of range is really pretty slick. I plan to go to Oshkosh this year at 23,000 feet, nonstop, 210 knots, on less gas than I went last year at 180 knots with one or two stops. That's big improvement—it's where we are going. □