

kind of aircraft. Its longest flight was 5 miles, which the ship covered in 23 minutes. The electric motor was 9 horsepower, and the batteries 970 pounds, giving the La France 108 pounds/hp. Krebs was the technologist for the La France, and is a fascinating man with many inventions to his credit.

Little happened in electric airplane technology until the late 1970s when Larry Mauro built a solar-powered hang glider called the Solar Riser. The solar energy stored in its battery could power it for 3 to 5 minutes, enough to launch it to gliding altitude. In 1981, the Solar Challenger, built by Paul MacCready's AeroVironment Company, successfully completed a 163-mile man-carrying and record-breaking flight from France to England. The Solar Challenger had an empty weight of 200 pounds, and the 16,128 cells powered two 3-hp motors using solely photovoltaic cells that covered its wing and stabilizer. It had no batteries onboard and would slow down if passing under a cloud.

MacCready also developed unmanned electric aircraft such as the Pathfinder and Helios for NASA during this period. These aircraft (there were five of them) were powered by from six to 14 2-hp motors mounted in pods on a single flying wing. They were designed for high-altitude loitering with the solar cells collecting energy during the day to run the motors and recharge the lithium-ion batteries for uninterrupted flight at night. This series culminated with the Helios, which had a wingspan of 247 feet and flew to 95,000 feet. The



Paul MacCready's Pathfinder ran its eight electric motors from lithium ion batteries recharged by solar cells atop the wing.

Pathfinder-Plus is now on display at the Smithsonian's Steven F. Udvar-Hazy Center at Dulles Airport.

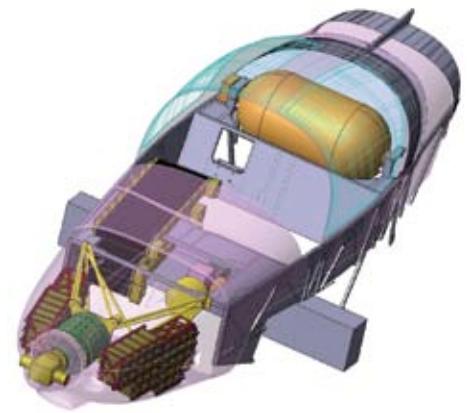
### Seeking the Sun

In 1990, Eric Raymond flew the Sunseeker across the United States much as the Wright VinFiz was flown across in 1911, that is, in short hops. The Sunseeker was a purpose-built solar motorglider that could take off and climb under power and then soar while recharging. It could fly up to 150 miles on solar and batteries, and Raymond also logged flights of 250 miles with additional thermal hopping. It was powered by an 8-hp brushless DC motor. In 2002, Sunseeker II was launched with many improvements. It is now on a tour of Europe, and earlier this year it became the first solar-powered aircraft to cross the Alps, 99 years after the Peruvian pilot Georges Chavez did so in a Bleriot. Sunseeker II has a gross weight of 506 pounds and a span of 56 feet.

At AirVenture 2008, two hits were based on John Monnett airplanes: Randal Fishman's ElectraFlyer-C (an electric Moni) and the E-Flight Initiative's Waix. The ElectraFlyer-C was designed as a prototype and based on a converted Moni motorglider. Fishman has founded the Electric Aircraft Corporation to develop and sell power systems for electric aircraft.

The ElectraFlyer-C is powered by an 18-hp (13.5 kW) electric motor, a pulse width modulation controller, and a 5.6 kWh lithium ion battery pack. It flies for 1 to 1.5 hours at a cruise speed of 70 mph with a max speed of 90 mph. Empty weight (with batteries) is 380 pounds, and max takeoff weight is 625 pounds. In a future issue, we'll explore the meaning and interrelationship of these values.

The E-Flight Initiative is focused on developing motors and controllers for electric aircraft. Working with John Monnett, the E-Flight Initiative folks are developing an electric Waix, powered by a 270-volt, 200-amp, brushless DC motor. It carries 200 pounds of lithium ion batteries and is designed to cruise at 70 mph using 30% power (4.5 kW) for an hour or to do acrobatics for 15



The SkySpark design is a fuel-cell hybrid that reached 155 mph in testing.

minutes. The design team has also been developing high-voltage and -amperage power inputs for a new system.

### New Designs

In June 2009, the SkySpark made its first public appearance. The SkySpark is a Turin Polytechnic University project aided by many technical sponsors. The SkySpark team's goal is to design and build a high-performance, single-seater able to fly at 186 mph for more than 2 hours. In the June 2009 flights, the aircraft was powered solely by batteries, but it is designed as a fuel-cell powered airplane with batteries only for auxiliary power. During these test flights it reached a top speed of 155 mph, a record (so they claim) for a 100% electrically powered aircraft. It is powered by a 75-kW electric motor using brushless technology and lithium polymer batteries.

The team is now focusing on the fuel-cell system, designed to produce 60 kW of power from 5.8 gallons of stored liquid hydrogen. Hydrogen is stored in a tank behind the pilot. The fuel cells are in the copilot position, and batteries are under the cowling, alongside the motor.

Also in June, the Yuneec E430, a 54-hp two-seat Chinese electric airplane made its first public appearance. What makes it unique (pun intended) is that it is the first electric aircraft designed to be commercially produced. The E430 is a Light Sport Aircraft that seats two and is made with lightweight composites. The 230-volt powerplant charges in 3 hours, and the manufacturer claims the plane will be able to fly for about 2.5 hours on a single charge. It will sell for \$89,000.

# Electric Planes at AirVenture

As author David Ullman says in the main story, battery-powered, electric-motor-propelled airplanes have flown at recent AirVenture fly-ins. But the pace quickened in 2009 with demonstrations by Flight Design's Tom Peghiny, who flew the nearly silent single-seat Yuneec ESpider ultralight frequently at the ultralight/rotorcraft strip, making many circuits on its rechargeable batteries.

About a mile north of the ultralight activity, much of the Education Center building space showcased electric planes, some of which have logged considerable e-flight time. Dominating the electric flight exhibit was the 20-meter-span German Antares 20E power-assisted production sailplane. Owner Dave Nadler demonstrated extending and retracting the large-diameter (2-meter) motor-driven pusher prop unit that substitutes for a towplane. He said that a battery charge is good for an altitude gain of about 10,000 feet, which might equate to four or five standard airplane tows. The Antares is said to cost about \$350,000.

On a considerably lower budget but also flying on electrons was Mark Beierle's eGull 2000—a modified Beierle Earthstar Aircraft Gull ultralight. Beierle says he has flown a total of about 6 hours for as long as an hour per charge with his 18-hp EMG pancake-style, high-torque brushed motor. Two boxes of lithium poly 4900-milliamp-hour model airplane batteries supply the power. Cells are in series and parallel to provide 72 volts at 25 amps. "Once you experience how smooth and quiet electric power is," he said, "you really don't want to fly anything else."

Two years ago Sonex unveiled the mockup of an electric power system on one of its Waix homebuilt kits. This year the mockup parts have been replaced by a flightworthy brushless motor, sensorless motor controller and big lithium poly battery packs. Jeremy Monnett and Pete Buck of Sonex roped off their area in the Education Center for a low-speed demo windup of the system. They say first flights will occur soon.

Back at AirVenture 2007, Randall Fishman demonstrated his electric trike (powered hang glider), and in 2008 his modified electric Monnett Moni was flown for the Oshkosh crowd by Joe Bennes a few days after Fishman received the August Rasket award for aviation innovation. All along, Fishman said, his objective was to develop a practical two-seat electric airplane for quiet local flying. His all-composite ElectraFlyer-X was on display last summer with the other electrics, but it had not yet flown. The airplane uses a 50-hp, three-phase, liquid-cooled brushless motor. Like the electric Waix, Fishman's ElectraFlyer-X is expected to launch soon.

—Dave Martin



Tom Peghiny shows the Yuneec ESpider in multiple trips around the ultralight pattern.



Dave Nader's 20-meter self-launching electric Antares sailplane is in commercial production in Germany.



Mark Beierle's eGull 2000, when equipped with its PowerFin propeller, has lofted him more than an hour on a battery charge.