Energized

RICHARD STEEVES' ELECTRIC EGULL ULTRALIGHT

BY HAL BRYAN

RICHARD STEEVES, EAA 65309, isn't a salesman. However, the mixture of his keen intelligence and his gentle and articulate enthusiasm is so compelling, he might have been a great one. Instead, he's a recently retired doctor who specialized in radiation oncology, an environmentalist, an enthusiastic proponent of nuclear power, and a longtime pilot.

PHOTOGRAPHER

Richard grew up in Ontario, Canada, skipped the fourth and eighth grades, and still describes school as "not very challenging." He was an avid scuba diver and designed and built his own underwater sea sled. In 1959, when he was halfway through medical school, he took a summer job on the shores of Lake Huron with the Canadian Department of Fisheries. He took inspiration from the aquatic insects he'd been studying and decided to learn to fly. He joined the Algoma Flying Club in nearby Sault Ste. Marie, Michigan, and did his training in a Piper J-3 on floats, only getting an endorsement to fly on wheels when he returned to school in London, Ontario, that fall. In 1971, he saw a story in *COPA Flight* magazine about Molt Taylor's Coot amphibian. He ordered plans, joined his local EAA chapter, and built his Coot over the next 11 years, starting a decadeslong relationship with the type. He moved from Canada to the Madison, Wisconsin, area in 1980. The move slowed the build down a bit, but he loved being closer to Oshkosh.

SHE HAD A POINT

Around 2011, Richard's wife brought up the efficiency of his airplane.

"My wife said to me, 'Richard, you're driving a hybrid car, you get good fuel mileage, but that Coot of yours only gets 10 miles to the gallon, and it's very, very noisy,'" Richard said. "I recognized that she had a point, and I had had a lot of fun flying my two Coots for 28 years, so I sold [my current airplane] to a physician in New Brunswick, Canada, and started looking around for electric planes."

Richard said it was a difficult four years. Finally, he ran into Mark Beierle, EAA 47579, courtesy of science writer Dean Sigler.

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>
> — RICHARD STEEVES

"[Dean] introduced me to Mark, and the rest is history," he said. "This plane came six months later after I was just about ready to give up flying altogether, and it's given me enormous joy for the past five years."

The airplane that came into Richard's life was an Earthstar eGull he named *Bravo*, an electric version of the popular Earthstar Gull series designed by Richard's new friend Mark. Mark, the owner of and brains behind Earthstar Aircraft, started flight training when he was 12 years old, soloed at 16, and got his private at 17 with more than 200 hours logged when he took his checkride. Over the years, he got hands-on with a lot of airplanes, working on restorations and eventually his own designs. The first of the Gull series, the Laughing Gull, was introduced in 1976. This quickly evolved into the Thunder Gull, a high-wing, tricycle-gear pusher ultralight that led to a series of variants, including the upgraded Gull 2000, the two-seat Odyssey, and a motorglider version called the Soaring Gull. The Soaring Gull, with its extended 28-foot wing, was the basis for the eGull.

ELECTRIFYING

"Mark had been busy designing light, efficient ultralights for quite a while," Richard said. "In 2008, the bottom dropped out of a lot of markets, including the ultralight market, and he had long been interested in electric propulsion of aircraft. And he felt that this plane was an ideal candidate for electric power. And so, he started working with Zero electric motorcycles, and he managed to — which I thought was a brilliant idea — get them to work with him well enough so that he could take the wiring, the controller, the computer, the battery, and the motor as a unit and transplant them from a motorcycle into a plane like this. It worked very, very well. Having seen some difficulties with other electric aircraft where you pick various parts here and there and they didn't often match, I recognized the importance of that, not only for efficiency but for safety."

Zero Motorcycles, based in Scotts Valley, California, was founded in 2006 and has been producing electric motorcycles in volume since 2010. Richard's eGull uses a 40 kW Zero electric motor matched with a brushless three-phase controller and integrated computer. While the eGull originally came standard with an 11.4 kWh lithium-polymer battery, as upgraded batteries became available from Zero, Richard switched to a 14.4 kWh unit that noticeably extended his endurance. (See sidebar.)

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Kilo-What-Now?

To those (read: pretty much all) of us who are used to the world of internal combustion engines in cars, airplanes, and other things, operating an electrically powered vehicle means learning a new language. The concept of kilowatts and kilowatt-hours as units of power output and fuel is foreign and strange to pilots used to horsepower and gallons. But try explaining those units to someone who'd never heard of them.

"My fuel tank holds the equivalent of 240 pounds of wine, and this engine is as powerful as 100 horses, each lifting 550 pounds 1 foot off the ground in 1 second," you'd brag as eyes glazed over.

Electric power uses the watt as its base unit, and metric modifiers to keep the numbers manageable — 1 kilowatt (kW) is equal to 1,000 watts, and so on. A watt is defined as the power of 1 joule per second. Okay, what's a joule? A joule is the force of 1 newton acting on an object through a distance of 1 meter (about 3.3 feet). And a newton? That's the amount of force required to accelerate 1 kilogram (about 2.2 pounds) at the rate of 1 meter per second squared.

So, a 40 kW motor has the power of 40,000 watts/joules per second/newton-meters per second — it can push a lot of hypothetical kilograms a lot of hypothetical meters.

If it helps, just remember that 1 watt equals approximately 1.34 hp.

That's the motor, but what about the battery? Battery capacity is measured in kilowatt-hours. While a watt is a measure of power, a kilowatt-hour (kWh) is a measure of energy. Note that it's not kilowatts per hour. It doesn't measure consumption, only capacity, the same way that your 30-gallon gas tank tells us nothing about your airplane's endurance until we know how many of those gallons it burns per hour.

One kWh is the amount of energy used if you ran a 1,000-watt appliance for 1 hour. A 100-watt light bulb left on for 10 hours, then, would use 1 kWh (100 watts x 10 hours = 1,000 watt-hours = 1 kWh.)

The eGull's 40 kW motor should use 40 kWh per hour, then, right? So how does it fly for 1 hour and 15 minutes on a 14.4 kWh battery? Shouldn't the motor quit after about 22 minutes? No, just like the Lycoming O-360 in your Tubman 601 burns somewhere around 15 gallons of gas per hour at 100 percent power, and a bit less than half that if you throttle back to 50 percent, electric motors use less energy when you tell them to. Throttle back to save some energy and you can stay up longer.

eGull

“When I’m flying over water in a landplane, I feel more confident in an electric motor than I would with an internal combustion engine.”

– RICHARD STEEVES

Other than the motor, the eGull looks just like its internal combustion-powered counterparts. It consists of a welded steel tube fuselage covered with fiberglass skin. The wing is built around a 26-foot aluminum spar, with aluminum main ribs and aluminum skin bonded over foam nose ribs. With the fiberglass tips, the span is 28 feet, compared to 20, 24, or 26 feet for most of the Gull series. The wing is covered with a mix of aluminum and fabric — the leading edges and the large flaps are metal, while the ailerons and center sections of the wings are fabric. The tail section is connected to the fuselage by an aluminum boom and consists of a traditional rudder and a full flying stabilator. A small tail wheel on the bottom of the stabilator protects against over-rotation, and there’s a steerable nose wheel at the other end. The main gear is mounted on composite legs that flex to provide suspension.

Richard’s airplane was originally built as a standard Gull 2000. He worked with Mark to restore it and convert it to an eGull. He started by building the new extended wing in his hangar at the Sauk Prairie Airport (91C) northwest of Madison in the winter and spring of 2016. Mark helped him with the installation of the electric motor and associated systems and some eventual upgrades. Richard did some flying in California with Mark in his Odyssey to get a feel for the type, and then Mark helped check him out in his eGull once the time came.

Gull designer Mark Beierle worked closely with Richard to help him create the electric ultralight he really wanted.

AN ELECTRIC PILOT'S LIFE

Bravo's cockpit is clean and simple. A Dynon FlightDEK-D180 electronic flight instrument system provides everything you'd get from an analog six-pack and then some. In addition, a pair of LCDs provide detailed information on battery capacity, power output, etc. There's a traditional center stick, rudder pedals, and a potentiometer that serves as a throttle. When it's time to fly, Richard turns the key on, powers up the Dynon, and then toggles a kill switch. From there, as soon as he advances the throttle, the propeller starts moving. Takeoffs are short, lifting off at 50 mph, and climbs are steep at 55 mph. Richard will usually cruise at 50-60 mph. Mark helped him install a cowling around the motor before the two made an epic flight to Oshkosh in 2018 (see "To Oshkosh, Quietly," What Our Members Are Building/Restoring, February 2019). That streamlined cowling had a significant impact, reducing the motor's required power in cruise from 12 kW down to 8 kW. The streamlining and the upgraded battery give him a comfortable flying time of about an hour and 15 minutes on a full charge.

When asked what it takes for a typical pilot to transition to an electric aircraft like the eGull, Richard's emphasis is on things you can forget.

"Well, the first thing is there are a lot of things you don't have to worry about," he said. "You don't have to worry about carburetor heat and all those things that you have to worry about with the internal combustion engine."

However, you do have to think about charging the airplane. While plugging it in is even simpler than pumping avgas into a fuel tank, charging takes time. You have to plan ahead. There are two chargers in the airplane, wired so that both can charge the battery simultaneously from a 110- or 220-volt source. Plugging one charger into a typical 110-volt outlet takes several hours for a full charge, so if he has to charge it that way, Richard will do that overnight. By using one 110-volt source and one 220-volt source, the setup he has in his hangar, he can get a full charge in about three-and-a-half hours.

Earthstar eGull 2000

LENGTH:	18 feet, 3 inches
WINGSPAN:	28 feet
HEIGHT:	5 feet, 3 inches
MAXIMUM GROSS WEIGHT:	550 pounds
EMPTY WEIGHT:	~250 pounds
BATTERY CAPACITY:	14.4 kWh
SEATS:	1
POWERPLANT MAKE & MODEL:	Zero Z-Force 40 kW motor
HORSEPOWER:	55 (estimated)
PROPELLER:	Duc composite three-blade
CRUISE SPEED/ENDURANCE:	50-60 mph/1 hour (with a 15-30-minute reserve)
MAXIMUM SPEED:	63 mph
RANGE:	50 miles (with reserve)
POWER LOADING:	10.2 pounds/hp (estimated)
WING LOADING:	4.1 pounds/square foot
V_{NE}:	120 mph
V_{SO}:	22 mph

PHOTOGRAPHY BY **PHOTOGRAPHER**

Richard named his ultralight Bravo *after the last letter in his U.S.U.A. registration.* Bravo*'s panel is built around a Dynon display supplemented by specialty gauges that came with the battery and motor from Zero Motorcycle.*

Interestingly, he doesn't charge *Bravo* after every flight.

"I often fly for three short trips of 20-25 minutes each before bothering to recharge overnight," he said.

While he's equipped to charge the battery more quickly in his hangar, he does overnight charges at 110 volts at regular intervals, per Mark's advice, which he said keeps the cells balanced.

He keeps a detailed log of his charging times and tracks the total number of charges and discharges, as the battery is expected to be good for 3,000 of each over its lifetime. Temperature is also a factor. In the winter, Richard only flies when the previous night's temperatures didn't dip much below 32 degrees Fahrenheit. In the summer, the manufacturer recommends only flying when the ambient temperature is less than 100 degrees Fahrenheit.

BRAVO

As for his airplane's name, Richard chose the last letter of the registration assigned to him by the U.S. Ultralight Association, E016WB.

"I chose *Bravo* because I'm so proud of it being electric, and I've moved beyond internal combustion engines," he said.

That pride shines through when he talks about wanting other pilots to try an electric airplane.

"I think that more people should consider electric flight," Richard said. "There is the same reluctance and perhaps greater reluctance in airplanes than in cars because in cars you just have to find an electric outlet. But the security and the manufacture of batteries today give me a greater feeling of security than worrying about whether a connecting rod or a piston might fire through the case. ... When I'm flying over water in a landplane, I feel more confident in an electric motor than I would with an internal combustion engine."

In addition to that sense of security, Richard touts the simplicity and cleanliness of electric flight as strong selling points, as well as his appreciation of the reduced emissions. Electricity at his home base comes from a nearby hydroelectric dam, so for him, the fact that he's not indirectly using coal energy is also a plus.

At the end of the day, though, the most important thing is that it's a fun airplane to fly.

"I can't say enough positive about it," he said. "It's my joy." EAA

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