



THE FUTURE:



ELECTRIC BOATS

When will battery-powered craft become practical?
Sooner than you think.

BY VINCENT DANIELLO

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RESIDENT GROVER CLEVELAND pushed a button and the world changed. He was in Chicago at the 1893 World's Columbian Exposition celebrating Christopher Columbus' first voyage. For the first time on a large scale, 11,000 kilowatts of electricity illuminated 250,000 electric light bulbs, instantaneously igniting wonder in everyone. Scores of electric motors also silently sparked life into fair exhibits, enkindling the imaginations of industrialists and entrepreneurs.

That historical spring day was an exciting time not just for electricity, but for all innovation. Fair-goers experienced the first motion-picture theater and saw their first automobile — a 1.8-horsepower Daimler. They watched the Chicago Athletic Association football team beat West Point 14-0 in the first successful night football game. They soared, 2,160 passengers at a time, 264 feet above the fair's central Midway Plaisance Park aboard George Ferris' massive steel revolving wheel, and they glided among exhibition halls to only the sound of water against hulls and passengers' conversations in 55 impeccably varnished 36-foot battery-powered launches.

"All 55 of those boats sold like hot cakes after the fair," says Joseph Fleming, who for a decade-plus

owned the Electric Launch Co. (Elco), the builder that emerged from those vessels. The first Elco sales weren't just riding a wave of excitement generated by the 27 million fair attendees; they were solving other problems too. Steam-powered boats in the United States, even tiny private yachts, required a licensed engineer. Naphtha engines were a passable yacht alternative, but both steam and naphtha raised serious safety concerns. Electricity

was simply the most practical method to propel a powerboat in 1893, and seemingly far into the future.

Fate, however, sidestepped electric propulsion. Two months before the fair closed that autumn, Rudolf Diesel ran his first prototype engine. Gottlieb Daimler, who actually honeymooned at the Chicago event, had been the first to put a gasoline engine in a powerboat, in 1886. By the early 1900s, cars and boats would go faster and farther with a tankful of liquid fuel than with batteries, and the best technology rapidly won out. Some people predicted it would be 135 years — two decades from now — before technology tipped the other way and all-size electric boats became as ubiquitous as household electricity.

Twenty years from now? Or might it happen sooner? Consider that NASA and Boeing are jointly projecting commuter-class, battery-powered jet aircraft in 10 to 20 years, and battery-powered 737-size planes in just 30 years. Once batteries and electric motors provide the same horsepower and range in the same weight as diesel, electric power will spread as quickly as the Model T Ford when it went from 10,000 produced



Bishop Stires, whose family owned *Wenona*, added tiller steering and an auxiliary motor controller at the stern, in addition to the original wheel and motor controller at the bow, to facilitate his trolling on Lake George, New York.



in its inaugural 1909 model year to more than 3 million on the streets by 1919, with technology that had been solidified into Daimler's automobile just one year before that Chicago fair.

Being green won't be the driving force toward electric propulsion, either. Lower operating costs will. Consider the 32-foot *Wenona* built by Elco in 1899 and recently refurbished by Hall's Boat Corp. in Lake George, New York. The boat is still running on her original electric motor and controller after 115 years of not particularly gentle use. "Somewhere around 1,000 to 3,000 hours, a DC motor needs to have the brushes replaced and commutator dressed," Fleming says, but little else.

Both were completed, and *Wenona's* electric motor was rewound with new copper wire. The original electric controller — a rotating wooden, brass and copper 10-pole switch that alters connections between two battery banks and two resistors to vary her speed — also needed surprisingly little work.

Fleming, an electrical engineer by training, became one of the largest suppliers of industrial AC motor controllers before selling his company in 1983 and then becoming involved with Elco, which has since changed hands a few times. Fleming is now back aboard heading up Elco's engineering. Five years ago he switched its boats from DC motors to three-phase AC motors. AC was proved the

Electricity was the most practical propulsion choice in 1893 for the 55 launches that ferried ticket holders at the World's Columbian Exposition.

Elco's 36-foot electric boats debuted at the famous Chicago fair and experienced brisk sales after the event.



“A 250-HORSEPOWER MOTOR WILL WEIGH 10 POUNDS AND FIT IN YOUR ARMS.”
— JOSEPH FLEMING, ELCO



Battery technology leaves electric propulsion short for planing boats, but for displacement boats, Elco's electric motors are a bit smaller than the 6-, 12-, 20-, 40-, 70- and 100-horsepower diesels they're designed to replace.

again eclipse internal combustion engines in our lifetimes: the power stored in each pound of battery. *Wenona's* original batteries, nickel iron plates immersed in potassium hydroxide held in large glass containers, offered a bit less than half the power per pound of lead-acid batteries 100 years later, but lithium has nearly quadrupled that power again in just over a decade. “Within five years, there will be major improvements over lithium iron phosphate batteries we have today,” Fleming says, pointing out current technology harnesses less than 15 percent of lithium's potential.

Batteries currently store considerably less energy than fossil fuel does, but emerging battery technologies using spongelike metal cathode structures to increase internal surface area, as well as alternative metals, promise rapidly changing capabilities. “It's entirely conceivable that in 20 years we'll have batteries that are eight or 10 times what lithium is today,” Fleming says. The big area of improvement for electric motors, Fleming adds, is in size and weight. *Wenona's* 5-horsepower motor weighs 250 pounds. “We'll see electric motors making 25 horsepower per

pound,” Fleming says. “A 250-horsepower motor will weigh 10 pounds and fit in your arms.”

Once the combined weight of electric motors and batteries is less than the same weight of diesel fuel and diesels, planing hulls will go farther and faster using electricity. There will simply be no practical reason to install an internal combustion engine. “A company founded on electric propulsion because it was the best available technology at the turn of the century built [boats] with gas engines because it was the only way to stay financially afloat then, and has now converted them to electric power because it's the future of boating,” Fleming says. “We're at the beginning of a tidal wave. Everything that moves — cars, trucks, trains, boats and planes — they'll all be electric.”

Elco's bright beginnings at the fair dulled once gasoline dominated propulsion. Electric Boat Co., makers of diesel-electric submarines, bought Elco before World War I. Elco continued building boats, many gasoline-powered, including 399 PT boats during World War II. With the Cold War, General Dynamics — renamed from Electric Boat Co. — led the development of nuclear subs, and small-yacht production faded into a pile of records in a New Jersey warehouse, until Fleming's vision revived the company.

“In *Wenona*, we're running 115-year-old technology today,” Fleming says. Can the same be said for gas or diesel boats built today? Only once they're repowered to electric. ♣

better choice all the way back in 1893 when George Westinghouse powered the fair with it, but AC propulsion wasn't practical for battery-powered boats until recently, thanks to advances in inverter technology that converts DC to variable frequency AC.

With Elco's switch to AC, its electric motors require no maintenance for 50,000 hours, Fleming says. Propeller speed and direction — down to 1 rpm at full torque — are handled entirely within the motor's solid-state controller, negating the need for transmissions too.

“With mechanical drag from the brushes and electrical losses in the armature and field windings, DC motors will never be as efficient as AC motors,” Fleming says. *Wenona's* 1899 DC motor uses about 80 percent of its battery power for propulsion, while the best diesels convert about 35 percent of their fuel energy into shaft revolutions. In gasoline motors, it's about 25 percent. “AC motors were over 90 percent efficient 50 years ago,” Fleming says.

Wenona illuminates the reason gasoline and diesel won out a century ago, and why electricity will

Wenona's original electric motor uses about 80 percent of its battery power for propulsion. The best diesels convert about 35 percent of fuel.

GREEN MACHINE: A CLASSIC UPGRADE

Elco recently brought *Green Machine*, a 1941 gas-engine 34-foot Cruisette, into the 21st century. Her 18 size 8D absorbed glass mat batteries power a 70 hp electric motor pushing the boat 80 nautical miles at 5 knots. Today's

best lithium iron phosphate batteries would triple her battery-only range for the same weight. A generator and 36 gallons of diesel currently extend her range another 580 miles, while the same 36 gallons of gasoline would net

only 195 miles beyond batteries. But here's the thing: A fourfold increase in battery power pushes *Green Machine* as far, pound for pound, as a gas generator, and packs 10 times more battery punch per pound than diesels. — V.F.D.