PRACTICAL SOLUTIONS

ALEC BRAINERD

Power That Fits

Advances in electrical propulsion provide options for auxiliary power in boats that can't accommodate internal-combustion engines.

by Aaron Porter

Above—*The 24'6" (7.5m) Watch Hill 15 launched in June 2011 by Artisan Boatworks in Rockport, Maine, was back in the shop in October for installation of a Mastervolt PodMaster. The 1898 design had no bilge space for conventional auxiliary power, but the battery-powered pod with a feathering prop could be mounted outside the hull.*

Driven by high fuel prices and concern about emissions from internal-combustion engines, researchers have accelerated the efficiencies of battery technologies and electrical propulsion in the past decade to give us commercially viable electric cars. Eager to exploit those advances, the marine sector has created a corresponding boom in hybrid and electrical propulsion options over the past six years. And while much enthusiasm and marketing have been focused on the perceived "green" value of electric propulsion as a quiet, efficient, low-emissions alternative to conventional gasoline or diesel engines, there are some cases, especially in smaller boats, where space is at a premium, and the new technology just fits better.

Alec Brainerd owns and operates Artisan Boatworks in Rockport, Maine, specializing in custom wooden boat construction, restoration, and storage. But since going out on his own in 2002, Brainerd has really made his name by building daysailers—chiefly knockabouts—designed by the likes of Herreshoff, Crowninshield, and Alden to serve the vaguely tribal New England sailing clubs of the early 20th century. At that time, different clubs would commission their own designs and have fleets of boats built for one-design competitive sailing. Some lasted, others faded from use, but in general the better incarnations of the

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The Watch Hill 15 is primarily a beautiful and able daysailer, but the addition of electric propulsion ensures that her owner can get home if the wind dies, and off the dock if the boat is pinned there by a crosswind.

type were shorter than 30′ (9.1m), sloop-rigged, fine-ended with a relatively spacious cockpit and minimal to nonexistent accommodations, and they were exciting to sail. As pure sailing machines, they didn't have auxiliary engines and, in many cases, simply didn't have space for them. That's where Brainerd has run into problems in repurposing some of these classic designs for modern recreational day-sailing, and where new pod-drive options for electrical propulsion from Mastervolt have offered a modern solution.

In February 2011, Brainerd was commissioned to build a Watch Hill 15, a Marconi rigged version of the 1898 Buzzards Bay 15 design from Nathanael Herreshoff. The 24′6″ (7.5m) centerboard sloop has a beam of 6′8″ (2m), carries 330 sq ft (30.6m^2) of sail, and displaces 2,200 lbs (998 kg).

"From the start, we knew that auxiliary power was necessary," Brainerd said. But there was no space beneath the sole of the spacious cockpit for a prop shaft, much less an engine to power it. Launched in June, the boat sailed her first summer season in New England carrying an electric outboard. Whenever it was needed, someone had to lug the thing out of the cuddy cabin and install it on a bracket. It was inconvenient, inelegant, and out of keeping with the relaxing recreational sailing the owner had in mind for the boat. "He hated it," Brainerd said. "It detracted from his use of the boat."

The builder started casting about for other solutions. Another of his clients had his boat equipped with an Elco electrical drive system (see *Professional BoatBuilder* No.135, page 7) consisting of an electric motor in the bilge, belted to a conventional shaft and propeller in an aperture. But while that system took up less space than even the smallest diesel, it was still too big for the Watch Hill 15.

"There's no bilge space at all," Brainerd said. He didn't want to install a box in the middle of the cockpit, because all the components of any system would have to be hidden under seats, sidedecks, in the cuddy, or outside the hull.

With the help of Kevin Boughton at Midcoast Marine Electronics (Rockland, Maine), though, Brainerd came up with a solution that placed the system components in exactly these same locations.

System Design

The real breakthrough came when Brainerd and Boughton discovered the Mastervolt PodMaster, an electric pod-drive system that would allow them to install the propulsion motor outside the hull. The drive leg of the 2-kW model projects just 8⅓″ (212mm) below the mounting surface on the hull, which meant it could be protected by the deadwood of the keel even on this centerboard boat. The owner gave Brainerd a positive response to the idea, so he and Boughton planned to install the system during a narrow work window when the boat could be back in the shop in the fall of 2011.

Because Mastervolt's electric drives are just one small part of the company's line of versatile and compatible marine electrical components, Brainerd deferred to the manufacturer's representative on system specifics. Mastervolt dealer Ocean Options (Tiverton, Rhode Island) spec'd a system that would deliver upward of two hours run time on a full charge. Brainerd explained that this is intended as a true auxiliary with the capacity to get what is, after all, a very smart sailing boat on and off the dock as well as home from an afternoon excursion if the wind dies. The package comprised a 100-amp charger, two Slimline 200-amp 12V AGM (absorbed glass mat) batteries, a controller for the motor, along with Mastervolt's MasterView readout and associated shunts, fuses, and connectors to tie it all together. The weight of the components and their approximate locations in the boat were also factored into the system's design.

Installation

What arrived in Brainerd's shop in late fall was a very complete if simple system. "The lead time on this is about a month," Boughton said. "But when it arrives, the package is

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The pod is fitted as close to the keel as possible to keep its weight near amidships and to protect it in the event of grounding.

done—as the electrician, you just have to spec the right wire." In this case, it was about 50′ (15.2m) of heavy cable to connect batteries, charger, controller, and electric motor.

The greater effort fell to the building crew, who had to place all the components out of sight, out of the weather, and where they wouldn't unbalance the boat. The 50-lb (22.7-kg) cast-aluminum pod unit, including the 2-kW 24V permanent magnet electric-drive motor and bronze two-bladed feathering prop, had to be off center. The trick was to locate it as close to the centerline of the narrow hull as possible to maintain trim, to minimize the effect of drag on steering, and to site the bulbous pod close to the keel, making the former less vulnerable in the event of a grounding and less likely to snag lines in the water.

To mount the pod, the crew crafted an exterior mahogany shim backed by a mahogany block and G-10 composite plate on the inside of the ⅝″ (16mm) Port Orford cedar strip-planking. Through the shim, they drilled the only three hull penetrations the installation required: two for mounting bolts, and one for the power cable to the motor. As a practical observation, Brainerd noted that this simple footprint makes the installation eminently reversible should a new owner want to remove the system to restore the classic to one-design competition.

"There are three holes in the hull," he said. "Three bungs, and it's like it never was there."

"It's like installing a transducer," Boughton added.

Components installed inside the hull demanded the same consideration of weight distribution, but also had to be out of the way without being inaccessible; and, as many of them are not waterproof, they had to be located where bilgewater and rainwater would be unlikely to reach them. At 120 lbs (54.4 kg) apiece, the two batteries are the heaviest elements. Since these sealed-cell batteries can be stored in any orientation, they were bolted to the underside of the cockpit seats to keep them clear of water in all but the most extreme swamping situations. This also allowed for them to counter one another in terms of lateral trim and to be situated close to the center of buoyancy longitudinally. Brainerd had custom bronze shields fabricated to hide and protect the batteries' plastic housings.

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With all components installed, the cockpit remains as spacious as Herreshoff drew it. The only visible system components are the throttle control under the starboard-side deck and the bronze shields concealing 200-amp batteries under the port and starboard seats.

Electric Cat

Tony Davis of Arey's Pond Boat Yard (South Orleans, Massachusetts) specializes in building traditional Cape Cod–style catboats in fiberglass or cold-molded wood and epoxy. The boats are broad but shallow, which means they have the volume to house auxiliary power, but a conventional marine diesel doesn't really fit in the space available. "There's just not enough room

TONY DAVIS

A 16′ (4.9m) Cape Cod–style catboat from Arey's Pond Boat Yard in South Orleans, Massachusetts, fitted with a 2.5-kW MasterDrive system, serves as a launch for an 84′ (25.6m) motoryacht as well as being a fully functioning, lively daysailer.

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Far left—*The teal-and-gray 100-amp charger is tucked in high on a custom shelf to port, just inside the cuddy cabin.* ***Left—****Under another shelf to starboard are the controller, which regulates power to the motor in the pod, and the key switch and MasterView display. All these components must be kept out of the weather, a challenge on such a small vessel.*

Because the controller and battery charger are not waterproof, they were installed on opposite sides of the boat in the shelter of the cuddy cabin. In addition, the small digital display (battery condition and remaining time under power), key switch, and the larger MasterView display were placed in the cuddy next to the controller. As installed, the most visible element is the subtle throttle and shifter under the starboard side deck within easy reach of the helm.

Complete installation time was just four days, after which the boat was shipped to her winter sailing grounds in Florida.

Performance

Brainerd recently reported that the new system has consistently pleased the owner, and the only hiccup in performance was a feathering prop that wouldn't feather. It was promptly diagnosed and put right under warranty by a Mastervolt representative.

The new equipment and associated cable have boosted the boat's weight to nearly 2,500 lbs (1,134 kg), according to Brainerd. But the distribution was just about perfect; she settled 1″ (25mm) on her waterline all around. Brainerd said if he were building a boat to accommodate such a system between the centerboard box and the transom for a diesel," Davis said of his 16′ (4.9m) model. But in 2010 a potential buyer asked him to build a fully functioning sailing catboat that would also be able to serve as a powered launch for his 84′ (25.6m) motoryacht. Davis said the client wanted a change from the ubiquitous large inflatable as tender. The catboat would have a classic look, the capacity to carry numerous guests and gear under power, and the ability to sail well recreationally, and it could be hoisted to a cradle on the deck for storage when the larger boat is under way.

Knowing a diesel was not practical, Davis looked at electric power options that would deliver the desired run time and range. While the catboat was obviously not going to be a high-speed launch, the owner wanted the capacity to run for about six hours at cruising speed—6 knots. The best fit Davis found at the time was Mastervolt's 2.5-kW MasterDrive system, which mounts an electric motor in the bilge coupled directly to a conventional shaft and propeller. Unlike the 24′6″ (7.5m) Watch Hill 15 (see main text), which only had room for a pod drive, Davis's catboat had enough space in the bilge to accommodate the MasterDrive motor with only a low box intruding into the cockpit aft of the centerboard trunk. But the controller and battery charger had to go under the foredeck, where they could be out of the way and the weather.

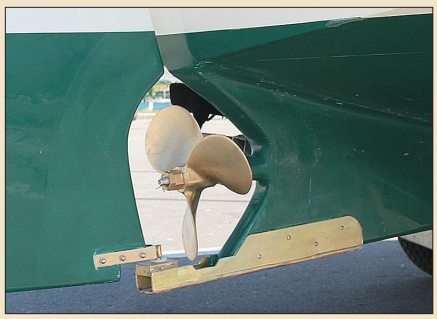
Davis said he had to calculate the additional weight of the system and adjust the boat's build technique to suit. In this case, he was able to offset much of the weight by specifying a carbon fiber mast and honeycomb core construction for a bulkhead and some of the furniture. He said he was able to install the heavy lithium-ion batteries under the port cockpit seat and counterbalanced them with an equivalent weight in lead to starboard. The installation also required cutting a custom aperture in the skeg to accommodate the prop.

Davis figures that at $17,000 installed, this system cost as much as $3,000 more than a small diesel and accompanying systems. But the owner reports great performance, with the boat capable of running close to its full designed run time without a power drop from the batteries running low.

"Less maintenance, no diesel, no noise—this makes your whole life with the boat different," he said.

—Aaron Porter

Right—*The catboat's shallow bilge houses the electric motor, coupled directly to a conventional shaft and propeller. Only a low box over the motor intrudes into the cockpit.* ***Far right—****A custom-cut aperture in the catboat's skeg accommodates the ample three-bladed prop, providing propulsion efficient enough to make the boat a practical tender.*



TONY DAVIS (BOTH)

from the start, he'd consider lightening the structure with a carbon fiber rig or the removal of some ballast. The boat is docked with access to shore power most of the time. The auxiliary allows the owner to leave and return to the dock with relative ease, and to power silently out to open water to set sail. Brainerd says the torque of the pod drive is far greater than that of the electric outboard. In part because the 2-kW pod can deliver a 2.4-kW blast of power right off the dock for about 30 seconds, getting on and off the dock in a strong crosswind is a real possibility.

Lessons

Brainerd now sees potential in the electric drive for other daysailers in wood or composites, or even in the more open so-called "raid" boats that are gaining in popularity. There's also the possibility that the systems could be retrofitted into existing smaller boats, making previously obscure craft more versatile and attractive to a broader market.

Brainerd and Boughton agree that they would install parts of the system differently on another boat. For instance, the Mastervolt 100-amp charger is not waterproof, and that would be a problem especially on a more open vessel. But other brands of chargers *are* waterproof and could be installed with the Mastervolt propulsion system. In retrospect, they question the need for such a big charger. Since this boat is tied up at the dock whenever it's not sailing, there's plenty of time for a 30-amp charger to top the batteries up overnight. On the other hand, if the boat had limited access to shore power, the larger charger would make sense.

Boughton notes that the MasterBus and MasterView, while important to more complex systems, aren't vital to this simple propulsion-only application. He adds that removing those components from this application and going with a smaller charger would have reduced cabling for the project by about two-thirds. (He cautions that a Mastervolt charger is essential in a system with Mastervolt lithium-ion batteries.)

Brainerd says that by opting for 100-amp batteries and settling for a reduced one-hour run time, about 100 lbs (45.3 kg) could have been saved. But that's a call for an owner to make, he concedes.

Still, compared to a small marine diesel (assuming one could be made to fit), the electric pod system on the Watch Hill 15 has a very similar components' cost of around $10,000. Installation was quick, and maintenance should be limited to replacement of a zinc every year, and of batteries in no less than a decade. And during that time, there's no need to ever visit the fuel dock, smell diesel fumes, or clean an oily bilge. Brainerd stresses that the real opportunity he sees in the technology comes from its versatility and flexibility of installation, the fact that he can now offer auxiliary power in models he never could before.

"It's a stunning sales opportunity on small daysailers," he says. PBB

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