PROFESSIONAL BOATBUILDER

The magazine for those working in design, construction, refit, and repair

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PART ONE: FOIL RENAISSANCE
FIGHTING DIESEL FOULING
A MODERN DIVE TENDER
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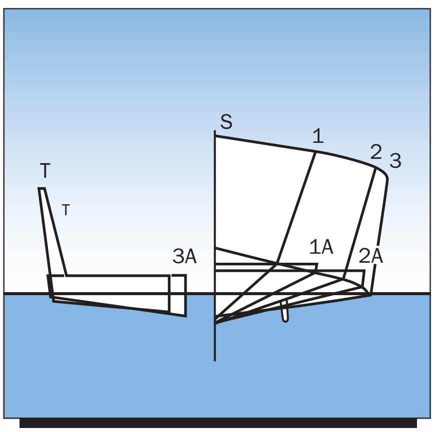
DENISE LARSEN

Making a Bayliner foil. Page 22.



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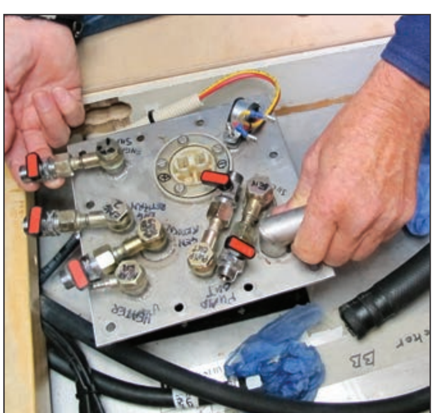

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On the cover: Harry Larsen, a retired applied mathematician who formerly worked for Boeing Marine Systems, hauls out *Talaria IV* at his property in Vashon Island, Washington. A longtime fan of hydrofoiling technology, Larsen fitted his 1980s-vintage Bayliner Monterey with custom retractable foils and a sophisticated control system of his own design to fully automate foilborne operation. Story on page 22.
Photograph by Dieter Loibner.

Early Exposure

Leon MacCorkle's response last December to a pointed opinion piece about workforce training in the magazine brought him to my voicemail and my attention. MacCorkle, who owns Padebco Boats (Round Pond, Maine), called to attest to the importance and practicality of the American Boat & Yacht Council's training opportunities for his employees. In his Parting Shot on page 76, you can read how he relies on the ABYC certification to assess employees' basic competency and then looks elsewhere in their résumés for the additional skills they're bound to have. MacCorkle, who came to the trade fresh off a firefighting career, expects that most of his employees bring unique experiences with them from prior professional pursuits as well. We agreed that it's a poor employer who doesn't identify and play to those talents.

Our conversation prompted me to think more about the nature of our workforce, not just how to train good workers and keep them happy but also *who* they are. The fact is, not many of us set out to be boatbuilders by embarking on a clear career path like, say, an accountant, attorney, electrician, or obstetrician does. Recruitment to our trade is more often driven by passion than by planning. MacCorkle observed that, "Most people in this industry fall into it because they love boats."

He's right.

Think of some of the industry leaders we've worked with or profiled in these pages. Kiko Villalon, who designed numerous powerboats and founded Marine Concepts, trained formally as an engineer for sugar production in his native Cuba. But he'd started sailing and building boats with his father in the 1940s, and that was the passion he spun into a successful career when the revolution displaced him to the U.S. Rod and Bob Johnstone, who came from collective professional backgrounds teaching school, designing submarine enginerooms, and marketing Quaker Oats, created J Boats in 1977 based on their enduring love for sailing and competition. Noted yacht designer and builder Dudley Dix was formally trained and worked as a quantity surveyor in South Africa before taking the Westlawn School of Yacht Design correspondence program and then professionally reverting to boats, a habit and skill he picked up as a boy dinghy-sailing with his father. Similarly, regular ProBoat contributor, boat designer, and yard operator Butch Dalrymple-Smith confessed that he'd taken up yacht design largely as a needed distraction while attending medical school. Our technical editor, Steve D'Antonio, studied political science at university and was working in a law firm before the boat addiction that started in his childhood pulled him into the trade. On page 22 of this issue, our new editor-at-large, Dieter Loibner, introduces us to Harry Larsen, a retired Boeing applied mathematician, who has developed his own foils and computerized ride-control system while working mainly in the same Vashon Island boatyard facility where he grew up surrounded by boats.

While none of these innovative builders, designers, or repairers took a direct route to their careers in boatbuilding, there is a common denominator: early exposure. They all started boating at a young age, and returned to that passion despite other intellectual, economic, and professional opportunities. For those of us concerned about the future workforce, exposing as many smart young men and women to boats and boatyards as possible is at least as important as agonizing over relevant and affordable formal career training. And keeping the door open to boat nuts who were infected as children to join the marine trades after partial or full careers elsewhere will only broaden and strengthen an already increasingly engaged and intelligent workforce.

Aaron S. Porter

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Pushing Batteries to the Limit

To the Editor:

I read Nigel Calder's article "Pushing Batteries to the Limit" (*Professional BoatBuilder* No. 170) with pleasure and great interest. I converted my cruising sailboat to a lithium-ion-battery-based electrical system in May 2014 (see my article "Chemical Conversion," PBB No. 155). After operating four seasons with lithium-ion batteries since then, here is an update, with additional information, based on our real-world experience.

As Calder and I pointed out in our articles, converting to lithium-ion batteries is *not* a "drop-in." My wife's and my four years of experience have convinced me that this is likely the most important point to remember when contemplating such a conversion. All aspects of the entire electrical system must be examined, including components, control systems, cabling, component and space cooling, and sizing of components in the context of normal boat operating patterns.

We have seen all the benefits described in these two PBB articles. In our case, our primary goal was to reduce generator run time. We exceeded our expectations. After finally getting the right alternator, discussed below, we are seeing approximately 80% reduction in genset run time compared to AGM batteries. This is a good way toward Nigel Calder's goal: to replenish the batteries with only the energy generated during normal boat operations.

I spent two years adapting and adjusting various "small-case" alternators, but never succeeded in solving the overheating issue caused by the alternator operating at near 100% capacity for extended periods. I changed to a "large-case" alternator two years ago, and it has worked flawlessly.

Reverse-mounted alternator with a 10-rib serpentine belt and tensioning device.

The large-case alternator does not fit alongside my engine as the original small-case alternator did, so I developed a robust custom "reverse mount" to move


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the alternator from its original position to the front of the engine.

High-capacity alternators require significant mechanical power to drive them. My 130-amp, 12V alternator uses about 5 hp (assuming 50% efficiency). This translates to reducing the engine speed by 100 rpm on my 100-hp [75-kW] Yanmar 4JH3-HTE engine. This means that the installation must use an alternator drive belt that can handle the load. I chose a 10-rib serpentine belt because its appropriate crankshaft and water pump pulleys were readily available for my Yanmar engine. The 10-rib serpentine-belt generator pulley was custom-made by JK Pulley & Manufacturing, St. Louis, Missouri.

The power transferred through the belt drive also means that the belt must be tightly tensioned. My alternator's custom reverse mount has a bolt-and-slider mechanism to tighten the belt, and I highly recommend such a robust mechanical means to set belt tension.

I chose a Mastervolt 130-amp, 12V alternator to stay with the same manufacturer for all major components in my electrical system. The manufacturer assured me that the alternator would have no overheating problems, and this proved correct. Although the external Mastervolt regulator can be set to monitor alternator temperature, the company recommended that it be configured to monitor lithium-ion-battery temperatures, and my system is set up to do that. I regularly monitored alternator temperature with a handheld IR device, and the temperatures have never approached design limits.

Engine-compartment temperatures did not change significantly with the new alternator.

I used the same manufacturer for the lithium-ion batteries, the inverter/charger, a second large charger, the alternator, the external alternator regulator, two DC-DC converters (to charge smaller AGM batteries), monitoring software, and the control system. In my opinion, this approach has paid off many times over. My vendor (Mastervolt) "took ownership" for the system. They played a key role in designing it, selecting and sizing its components, and configuring/tuning the system in operation. Their technical support was readily available and extremely valuable. They were able to take downloads from the monitoring software or view the boat's electrical system operation in real time if an Internet connection was available. Their control system enabled software updates of all components. Many of these changes have incorporated experience gained with their lithium batteries. In my opinion, this "seamless integration" has been invaluable in enabling us to focus on sailing rather than watching our electrical system while trying to sail.

I remain convinced that lithium-ion

batteries are, as Calder said, "ready for prime time" in our maritime environment.

Mark Lenci
Natick, Massachusetts

To the Editor:

As usual, Nigel Calder's article, this one on lithium-ion battery installations, was very illuminating. The points regarding alternator and wiring (over)loading are especially important for those designing and installing these systems.

It's worth noting that conventional gaseous firefighting agents including FM-200 and Novec 1230 are among the least effective to deal with lithium-ion battery fires. In the Material Safety Data Sheets (MSDSs) for all lithium-ion batteries I've encountered, these agents are conspicuous by their absence, and a Federal Aviation Administration analysis of fighting lithium-ion battery fires gives them very low marks. It appears that the most effective agents, according to those FAA reports (https://www.fire.tc. faa.gov/pdf/systems/May13Meeting/Hill-0513-ExtinguishmentofLithiumBatteriesrev2.pdf), are water, dry chemical, foam, and CO_2, none of which are common in the recreational marine industry for the automatic protection of battery banks, so there will be yet another learning curve here. Comparing LiFePo MSDSs to those of lead-acid/AGM batteries, it's debatable which is worse. The latter's MSDSs list, among other things, thermal runaway, explosions, leaking sulfuric acid, and release of explosive hydrogen gas. Yet, most cruising vessels have at least two banks of those batteries. It would be interesting to know the preferred approach for lithium battery bank installations: Should they be contained in a fire-resistant enclosure? Is that any more necessary than for lead acid batteries? What type of firefighting technology is best?

Regarding shore-power cables, I've encountered overloading, and melting of conventional legacy NEMA as well as SmartPlugs. I've also routinely run 120/240V, 50-amp services (legacy and SmartPlug) at a continuous 45–48 amps hour after hour with no cause for concern. The cables are designed to carry this load, but as Calder notes, the connections are not bolted and are therefore more vulnerable to high-resistance scenarios, overheating, etc., which could be exacerbated by lithium-ion battery charging. However, similar conditions occur frequently on vessels running HVAC systems, water heaters, clothes dryers, and galley stoves.

Finally, will the new alternator-type device Calder cites offer the charging capacity mentioned at idle speed when setting or retrieving an anchor, or entering/departing the slip (Calder's examples)? Even if it can, that energy must be converted from the engine to electricity, and for smaller engines and sailing auxiliaries it seems as if the necessary horsepower may be unavailable unless running at higher rpm, or is there more to this equation when using this product?

Steve D'Antonio
Steve D'Antonio Marine Consulting Inc.
Wake, Virginia

Nigel Calder responds:

With respect to firefighting agents, water is obviously the most available medium. However, the consequences of flooding a battery compartment must be carefully considered in the design phase. That said, the core safety goal with any lithium-ion battery installation must be to do everything possible to avoid a situation where firefighting becomes necessary. The ABYC is currently working on a standard for lithium-ion batteries. We are reviewing various abuse tests that could be incorporated into the standard, taking into account the operating conditions on boats, and the things that can go wrong in a marine and boating environment. Other organizations, such as UL, have standards with aggressive abuse testing. Once completed, I believe compliance with the ABYC standard, or some of these other standards, will ensure that installations are as safe as lead-acid installations. I definitely want this technology on my boat, but before I install any batteries, I want to know they have passed rigorous testing.

On the alternator side, the devices I have been testing do have the potential to overload an engine, especially at idle speeds and wide-open throttle. Most of the "magic sauce" in the system is on the control side. We have been working on this in one way or another for nine years now. We have Steve D'Antonio's concerns, and many others', covered. More on this will appear in a future article.

Internal Combustion's Backside

To the Editor:

Regarding Steve D'Antonio's article "Internal Combustion's Backside," (PBB No. 170), I would like to introduce a useful safety feature I have seen installed on a couple of sailboat exhaust systems, including my own. It is a small drain valve installed on the lower edge of a hydro-lift muffler. The valve I used was a ¼″ CPVC; it can withstand the temperature of the water downstream of the mixing elbow; it does not corrode; and the quarter-turn design supports easy visual inspection of the handle for open/closed status. The valve is located on the lower edge of the muffler where the vertical cylindrical section of the muffler inserts into the flange of the mounting base. This joint in the muffler assembly provides an extra-thick area (7⁄16″) to drill and tap for installing the ¼″-CPVC drain valve. Additionally, I added some thickened epoxy around the drain valve/muffler joint to help spread the stresses of a threaded connection. I located the drain valve under the inlet of the muffler so that the valve was generally protected from being a step or trip hazard, and the handle of the valve is easily accessible from inside the engine space and easily seen from outside the engine space.

The benefits of a small drain valve in a hydro-lift muffler are twofold:

- During repeated attempts to crank the engine, it is not necessary to close the seawater intake, potentially running the water pump dry for extended periods. In these situations, I prefer to open my drain valve and dump the seawater into the bilge, allowing the sump pump to remove the water. After successfully cranking the engine, a small amount of exhaust gas will leak from the open drain pipe, so be ready to close the valve or shut down the engine. If by chance I forget to close the drain valve after cranking the engine, the sump pump buzzer alerts me, and if this situation continues, then the bilge pump is activated and the associated alarm sounds.
- During situations of concern about following big seas filling the exhaust system from the exit on the transom, there is no need to close a seacock in the exhaust line *and* for the captain to remember (or the crew to know) to open the seacock in the exhaust line before cranking the engine. Again, opening the small drain valve on the muffler to the bilge can prevent small accumulations of seawater in the exhaust system over a long period of time from creating an unexpected catastrophic situation at a most inconvenient time—like a man-overboard event.

Over the years I have seen a couple of drain valve installations on other sailboat exhaust systems, but I have never seen anything in print about them. Are there any potential downsides or issues with the sailboat exhaust-system drain-valve installation described above?

Jim Lawrence
S/V Seamist
Panama City, Florida

Steve D'Antonio responds:

Jim Lawrence makes some useful and interesting points regarding the benefits of muffler drains. It's wise to drain a muffler during extended cranking, as well as for dealing with potential flooding from a following sea. I am, however, cautious about leaving this drain open, for fear that a siphon (which should not be possible with a properly set up siphon break) could lead to flooding. He notes the precautions he takes to prevent this, which are commendable. For more on antisiphon valves see https://www.proboat.com/2017/06/antisiphon-valves/.

The valve installation, with its protected location and support, also sounds reasonable, but the material chosen for the valve itself is of some concern. When it comes to raw-water plumbing, with rare exceptions I'm not an advocate of PVC or CPVC. In addition to lacking the necessary tensile strength and modulus of elasticity, it's unlikely that it could endure exposure to dry exhaust. All wet exhaust components should be capable of withstanding exposure to dry exhaust for at least as long as the hose and water lift muffler are. ABYC Guidelines on this subject are fairly clear:

"P-1.7.1.5. Hose used in wet exhaust systems shall comply with the performance requirements of SAE J2006, *Marine Exhaust Hose*, or UL1 129, *Standard for Wet Exhaust Components for Marine Engines*. All other exhaust system components shall meet the performance requirements of UL 1 129, *Standard for Wet Exhaust Components for Marine Engines*."

Provided the valve material meets this standard, it is acceptable. Otherwise, a material with greater resistance to high temperature may be required.

Bertram Is Back

To the Editor:

I noted with interest the image of the prop and strut on page 27 in "Bertram Is Back" (PBB No. 171). The prop nuts are on backward but not commented on. Since the SAE standard was established in either 1927 or 1929, the persistence of the incorrect placement by reputable boatbuilders is strange. Additionally, the shaft overhang looks as if it may be excessive.

Rex Miller CMS
Telrex Marine Services
Mundelein, Illinois

Aaron Porter responds:

I thank Mr. Miller for his close reading and perusal of Dan Spurr's article about Bertram's latest renaissance. His observation about the prop nuts is correct. The which-nut-first debate is not new to our Letters, Etc. column. Most especially I would refer readers to PBB technical editor Steve D'Antonio's extensive exchange on the subject in response to an insightful letter from Wesly Lilly, president of Saturn Marine Engineering. It starts on page 12 of PBB No. 121. Additional correspondence is in PBB Nos. 122, 123, and 124 on pages 9, 7, and 8, respectively. At that time, we received multiple notes and calls from ship and commercial tug mechanics asserting that—contrary to D'Antonio's advice, ABYC standards, and a half dozen engineering, military, and manufacturer texts—on larger vessels the big nut should be installed first. So be prepared to see both sequences in application out there. Indeed, a photo on the facing page of Spurr's article shows the nuts in a "proper" sequence on a shaft, though no prop is installed. Which illustrates the risk of looking at anything in a build shop and thinking it's a final assembly.

To read those letters in the back issues listed above, it's now easier than ever at our online back-issue archive (http://backissues.proboat.com). PBB

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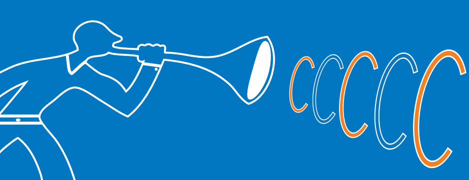

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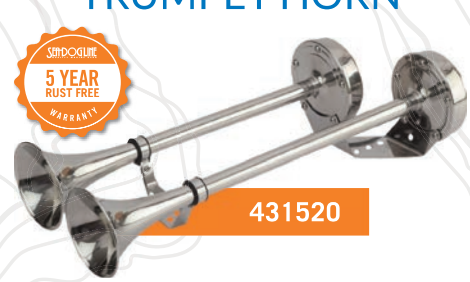

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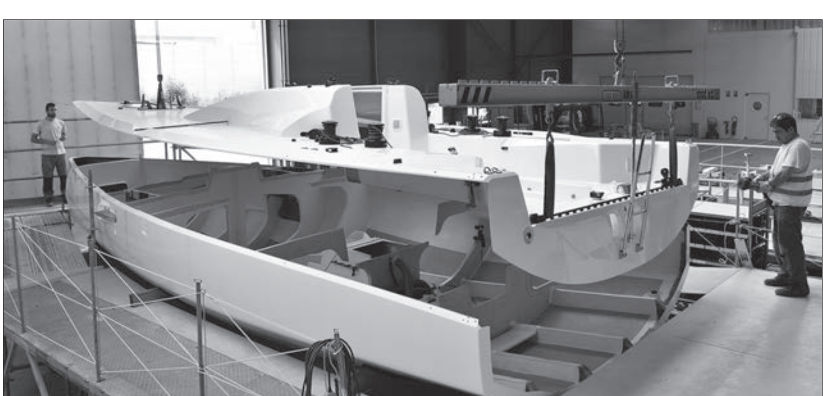
Compiled by Dan Spurr

A Bénéteau with Foils

The newest iteration of the one-design composite Figaro Bénéteau 3 is a 32' (9.75m) high-performance sloop with port and starboard curved foils that improve lift and stability. The boat was designed by multihull specialists VPLP Design for La Solitaire URGO Le Figaro, a multi-port race along the French and Spanish coasts.

Followers of extreme sailing may know of Bénéteau's several-year program to develop a production monohull with foils. Well, let's qualify the term *foils*. The new 32′ (9.75m) Figaro Bénéteau 3 does not rise out of the water like a Moth dinghy or multihulls on T-foil appendages installed on the centerline of the hull; instead, it has C-shaped port and starboard foils that increase lift and improve stability, while still retaining a deep, narrow-chord keel blade and ballast bulb. Bénéteau is jazzed, calling it "the world's first production foiling monohull." The concept resonated with members of the European yachting press, who chose the Figaro Bénéteau 3 as the European Yacht of the Year 2018 in the Special Yacht category.

The VPLP design was commissioned as a one-design for a specific event, the 2019 La Solitaire URGO Le Figaro. (For more on the French design firm VPLP, which specializes in long-distance monohull and multihull racing yachts, see *Professional BoatBuilder* No. 91.) This coastal multi-port event in France and Spain will mark the 50th anniversary of its running. The first, in 1970, was called the L'Aurore, after the sponsoring newspaper; in 1980, *Le Figaro* newspaper bought *L'Aurore*, and the name was changed. Later sponsors



COURTESY BÉNÉTEAU (ALL)

Left—*The deck, with hardware installed, is lowered onto the hull with bulkheads in place. Note the opening in the topsides for the port foil.* ***Right***—*Figaro's foils, built by Multiplast (Vannes, France), are totally rigid, though adjustable for different points of sail.*

The keel blade and bulb are positioned under the hull, ready for connection.

modified the name yet again; the word *Solitaire* refers to the singlehanded requirement of the event. The French love long-distance solo sailing in its many forms, including nonstop racing around the world. La Solitaire is regarded as a sort of training ground for the longer and more dangerous races, affording amateurs the opportunity to test their skills and talent for fund-raising. Price for the first 50 Figaro Bénéteau 3s was recently announced at the relatively modest €155,000 ($191,925). After that, the price jumps to €175,000 ($216,690).

In 1991 race organizers selected Group Finot to design the one-design boats, and Bénéteau to build them. A new design was created in 2003, and now a third one. The course and the four ports change each year, usually covering 1,500–2,000 nm along the coast of France and usually one other country, such as England, Ireland, or Spain. Time at sea is about 10–13 days.

Bénéteau has established a racing team that among other duties will oversee construction of the latest design at the old Jeanneau plant in Nantes-Cheviré. Bénéteau's Julien Ferre tells us that reinforcements are "multiaxial glass webs with polyester resin" and, "all the structural elements are made in DIAB PVC 80-kg foam in infusion." Bénéteau partnered with several subcontractors, including Multiplast (see PBB No. 90), which made the retractable carbon fiber foils. Ferre says, "The port and starboard [foils] are independent. There is a position to sail upwind and a position to sail downwind. In the inside position, the foil stays inside the Bmax value. There is also a rake forward/backward to adjust the incidence of each foil." Bénéteau's general manager, Gianguido Girotti, elaborated: "The idea is to make sure that when in use, they exploit at maximum [beam] the righting moment effect, and once closed, they do not [exceed] the beam of the [hull]." That way, mooring and road transport are easier without having to remove the foils.

Principal specifications: LOA 10.85m (35′9″), hull length 9.75m (32′), LWL 9m (29.5′), max beam 3.4m (11.2′), waterline beam 2.4m (7.9′), draft 2.5m (8.2′), displacement 2,900 kg (6,400 lbs), ballast 1,100 kg (2,400 lbs), sail area main and jib 70m² (753 sq ft).

Bénéteau, Gaëlle Violleau, tel. +33 (0) 251605204, website www.beneteau.com.

—Dan Spurr

Everett Pearson: A Major Force in FRP

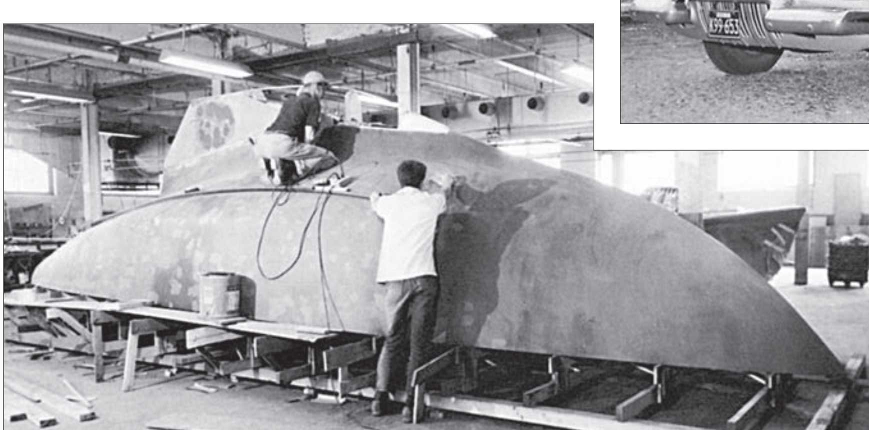
If one had to choose the most influential person in modern composite boatbuilding, you wouldn't lose any points naming Everett Pearson, who died on Christmas Eve 2017 at age 84.

Pearson Yachts was founded in 1956 by (left to right) Fred Heald and cousins Everett Pearson and Clinton Pearson.

Pearson's six decades in the boating business began while he was a senior at Brown University majoring in economics and was captain of the football team. He and cousin Clint Pearson made a plug for an 8′ (2.4m) fiberglass dinghy and to produce it rented space in an old textile plant on the Bristol, Rhode Island, waterfront. The Cub Dinghy was followed by the Plebe daysailer in 1957, five runabouts and the Pacer skiff in 1958, and in '59, most notably, the Carl Alberg–designed 28′6″ (8.7m) Triton auxiliary sailboat, often credited with launching the fiberglass boat into respectability. No longer were critics saying, "If God wanted fiberglass boats, He would have made fiberglass trees." The idea for such a boat originated with Tom Potter, a marketer associated with another boatbuilder in Rhode Island that was already trying to promote the Block Island 40 (12.2m), and not very successfully. Potter approached Cape Cod Shipbuilding and Sparkman & Stephens, who each told him the Triton was a bad idea. When he asked the Pearson cousins, Everett later related, "Being young and not knowing any better, we said, 'Sure.'" Over the next nine years they built 712 of them. Numerous other models in sail followed, plus a few in power that didn't sell as well.

I had the privilege of talking boats with Pearson on a number of occasions over the ensuing years. One of my strongest memories is recounted in my book *Heart of Glass*, in which Pearson debunked the popular notion that early fiberglass builders relied on wood boat scantlings to determine laminate thickness. One day, while working on the dinghies in Bristol, Dr. Press Veltman of the W.R. Grace Co. walked into the shop, chatted up Pearson, and offered the resources of his company in several significant areas. Pearson told him of problems with gelcoat cracking, even with premium materials from Glidden, Schenectady Paint & Varnish, and Naugatuck. "He taught me how to blend titanium dioxide into an inert polyester," Pearson said. "We started making our own gelcoat that was better in gloss and crack resistance than anything on the market." And when Pearson told Veltman about his plans for the Triton, saying he was

COURTESY *HEART OF GLASS*, BY DAN SPURR (ALL)



Above—*Pearson Yachts' first boats were small dinghies and runabouts, such as the 12' (3.7m) Pacer, shown here on top of Everett Pearson's 1950s-era Plymouth.* ***Left—****The wooden plug for the 28'6" (8.7m) Pearson Triton auxiliary sailboat was lofted from the shop floor in the company's first facility, an old textile plant on the Bristol, Rhode Island, waterfront.*

"trying to determine how strong to make this boat," Veltman told him to talk to designer Alberg and "find out what the loads are, make up some pieces, and we'll test them." W.R. Grace's test lab provided Pearson with data that was used to engineer a minimum 3:1 safety factor on most of the structure for the boat falling off a wave, and 5:1 for the ballast. "We spent the time to test our laminates," Pearson said. "But I can honestly say that 90% of the other boatbuilders had no idea. They were just slopping this stuff in and building the boats up."

Grumman Aircraft Engineering Corp. bought controlling interest in Pearson Yachts in 1960. Clint left in 1964 and Everett in 1966 to partner with latex king Neil Tillotson to form Tillotson-Pearson Industries in a new facility in Warren, Rhode Island. When his five-year no-compete clause expired, he turned again to boat production: Garry Hoyt's Freedom line of sailboats with unstayed rigs, Rampage sportfishermen, J Boats (beginning with the hugely successful J/24 of which more than 5,000 were built), Alden sail yachts, and cruising catamarans for the French Lagoon brand.

Not one to put all his eggs in one basket, Pearson diversified into industrial and unusual products: 27′–65′ (8.2m–19.7m) wind turbine blades for Kenetech Windpower, flatbed tractor trailers, bus bodies, airport people movers, Disneyland car rides, lighting poles, electric car bodies, bridge components, test torpedoes, and one of his favorites, the Swimex hydrotherapy pool that functions as a water treadmill. It's a mix unmatched by any other boatbuilder.

In 1993 Pearson partnered with Seemann Composites of Gulfport, Mississippi, and Hardcore Composites of New Castle, Delaware, to promote and license the SCRIMP (Seemann Composites Resin Infusion Molding Process) closed-mold method of infusing fiberglass, carbon fiber, Kevlar, and other fabrics with resin. The high reinforcement-to-resin ratios of around 70:30 were impossible with hand layup; and perhaps even more important, VOCs (volatile organic compounds) were captured and exhausted from the workplace. He once said one of his proudest achievements was making the laminator's job cleaner and healthier, boosting employee morale.

Pearson also is one of several persons who claim to have been first to orient balsa wood on the end-grain for use as a core material. He publicized an experiment in which he sank a sandwich panel of glass and balsa off his dock for a lengthy period, after which he showed that water migrated little beyond a superficial penetration. End-grain balsa became a commonly utilized core in hulls and decks for its light weight, stiffness, and superior stability over some foams.

While not the first person to build production fiberglass boats, as some believe, he and his cousin Clint were certainly prominent at the dawn of the new industry. Everett's foresight and innovations earned him the admiration and respect of more than one generation of boatbuilders.

—D.S.

In an unusual move for a design firm, Claydon Reeves has developed its own brand, Aeroboat, calling it "the ultimate day boat for the 21st century."

The British design studio Claydon Reeves (a partnership founded in 2010 by James Claydon and Mike Reeves) had a busy 2017, announcing the launching of several elite projects. Among them are the superyacht *Delta One*, built by the Mulder Shipyard in Scheveningen, The Netherlands, and Aeroboat, the studio's own brand of what might be called sport or express yachts, not an altogether-new concept but certainly an ambitious undertaking with eye-catching "richness" and flair. Claydon Reeves modestly calls them "day boats." Who said the Brits are dowdy?

The 36m (118′) *Delta One* is the first of six on the order books for Mulder; the second design is under way. Working with the Vickers Studio, Claydon Reeves created an interior with amenities not often found in a yacht this size: an aft deck offering a "full-headroom beach club with bar and bathroom facilities." Other notable features include a full-beam master suite with access to a private seating area at the bow, floor-to-ceiling windows for panoramic views, a folding side balcony, and a large cockpit with "*al fresco* seating and dining options."

Claydon Reeves's Andrew Johansson said he cannot share photos of the interior, per the client, but said all parties shared a passion for vintage sports cars, which informed the overall theme for the yacht's interior—"a form of relaxed Art Deco with an automotive twist. The strong chevron of the floor planking that runs from the exterior into the interior is a play upon the *Delta One* logo that we also developed for the client. The width of the planking is 12.75cm [5″], the width of the rear wheels on a car special to the owner. Elsewhere, leather straps recall vintage luggage combined with nickel and chrome detailing. The bar stools have 'tuck and roll' leather stitching and 'steering wheel' footrests. The chevron pattern runs onto the tabletop in marble, while above, an abstract light sculpture recalls the dappled light seen through avenues of trees when driving a car. Playful details abound, such as flip-down side tables that hold a glass of water tightly while mimicking the dash and gauge layout from the owner's favorite car."

Naval architecture for the all-aluminum yacht was performed by Van Oossanen Naval Architects (PBB No. 121), incorporating its Fast Displacement Hull Form (FDHF). As described six years ago in this column (PBB No. 134, page 10), the FDHF "attempts to bridge the efficiency gap between fast and cruising speeds." Perry van Oossanen, son of the firm's founder, Peter van Oossanen, said, "A hull well designed for a speed of 20 knots is usually not very efficient running at 12 or 13 knots, and vice versa. The hullform is a hybrid round-bilge that incorporates a chine in the forward part, [and] a small, immersed transom. It has 'smart' running trim control by means of a combination of specially shaped propeller tunnels (fitted with trim wedges), and adjustable interceptors." Also part of the package is a bulbous bow.

When asked if FDHF is evolving, Perry van Oossanen told us, "The FDHF is under continuous development in our office. We are also working

COURTESY OF CLAYDON REEVES (BOTH)

The British design firm Claydon Reeves created the interior of the 118' (36m) Delta One *using the owner's automobile fleet for inspiration. A nondisclosure agreement prevents publication of interior images.*

on its successors. Other recent projects using the FDHF are: *Galactica Super Nova* [70m, Heesen], *MY Home* [50m, Heesen], *MY Samurai* [60m, Alia Yachts], the RPA-8, a 25m [82′] Patrol Boat for the Rotterdam Harbour Company, and the Jetten Beach 45 [Jetten Shipyard]. We do not license the hullform to other NAs. The only way to use the FDHF is to order the naval architecture work from us."

Delta One is powered by twin Caterpillar C18 1,145-hp (857-kW) engines, delivering a cruising speed of 15 knots with an engine load of 67%.

Origins of the Aeroboat line date to 2013, when Claydon Reeves introduced the Aeroboat 50 (15.2m). Naval architecture for that model was done by BMT Nigel Gee; however, a builder has yet to be determined.

When asked why a design firm would want to build and market its own model line, Johansson said, "We saw a gap in the market for a really high-end day cruiser and wanted to do something that would set us apart from our peers. While we aren't the only studio to have set up a new brand, we are the first to take a design beyond a drawing and produce it. So many great ideas never come to be, and we strongly felt that there was space in the market for a line of boats of this standard ranging between 55′ and 100′-plus [16.8m and 30.5m]. And so we took our original Aeroboat and spent considerable time refining it before arriving at the 65′ [19.8m] Aeroboat S6. The goal with the Aeroboat S6 is to make the ultimate day boat for the 21st century."

BMT Nigel Gee, Building 14, Shamrock Quay, William St., Southampton SO14 5QL, U.K., tel. +44 (0) 23 8022 6655, website www.bmtng.com.

Claydon Reeves, Studio 4 Braxton Courtyard, Lymore Lane, Milford-on-Sea, Hampshire SO41 0TX, U.K., tel. +44 (0) 1590 643848, website www.claydonreeves.com.

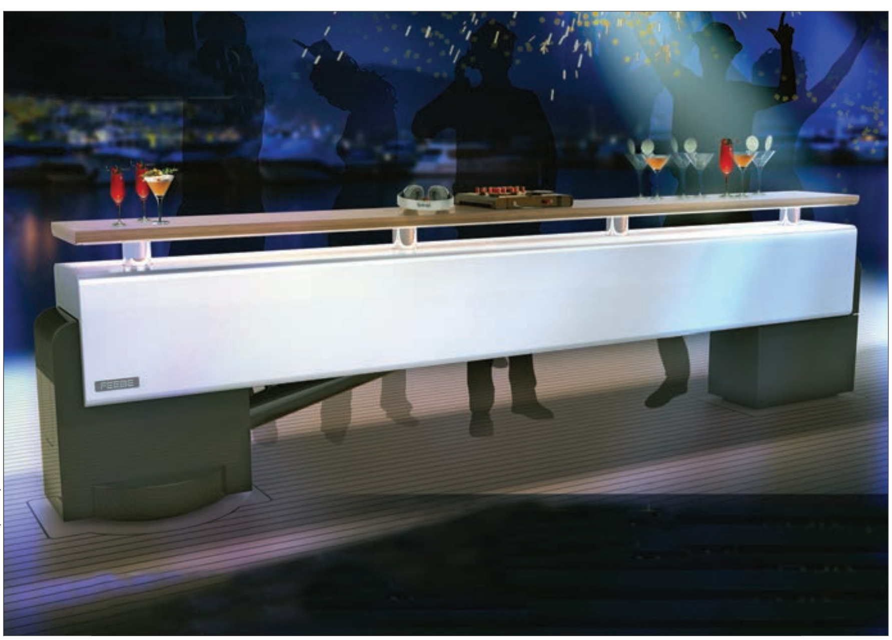
Van Oossanen Naval Architects B.V., Nude 46, 6702 DM Wageningen, The Netherlands, tel. +31 (0) 317 451573, website www.oossanen.nl. —*D.S.*.

What to Do with Unsightly Deck Cranes?

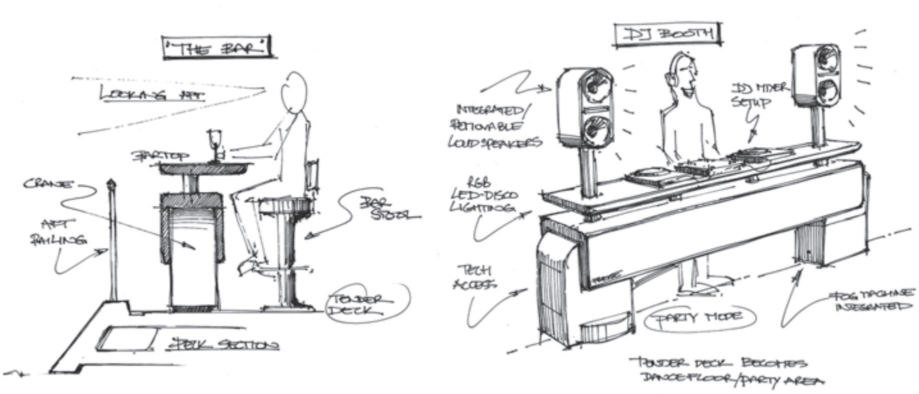
Big toys on big yachts can do all sorts of fun things…except launch themselves. Jet skis jump waves. RIBs ferry guests to and from clubs on shore. Center consoles speed the skipper and his pals away to the canyons for big-game fishing. Unless the toys are stored in a so-called garage at water level, to get from the deck to the briny blue requires a deck crane. And when not in use, which is most of the time, it just sits there like some Transformer waiting to animate itself and commit mayhem.

Ah, but a Dutch company has a clever solution. With the help of Bernd Weel Design, Feebe's 1,540-lb (700-kg) crane really does transform itself into other shapes, to wit, a beverage bar (of which there are never enough on a well-equipped yacht) or a DJ music station. Feebe invites other suggestions to meet individual and particular needs. They are anxious to accommodate.

Feebe, Ald Rij 10, 8822 WX Arum, The Netherlands, tel. +31 (0) 517 850 851, website www.feebe.nl. *—D.S.*



COURTESY FEEBE (BOTH)



The Dutch company Feebe is promoting its deck crane as a multifunctional accoutrement easily transformed into a bar, a DJ station, or a …?

Remembering Ian Farrier

New Zealand multihull designer and builder Ian Lindsay Farrier, 70, died suddenly in San Francisco, California, on December 8, 2017, culminating a career that began in 1973 in Australia.

While his early designs, many home built, were well known in New Zealand and Australia, it was the F-27 (8.2m) that made an impact in the U.S. The trimaran has a unique patented hinge mechanism enabling the amas (floats) to be folded inward toward the main hull even when afloat, making the boat easily trailerable. After its introduction in 1986, production grew from 12 the next year to 101 in 1991. Farrier's www.f-boat.com website includes an engaging account of how Walmart heir John Walton took interest in the design and founded Corsair Marine in Chula Vista, California, to produce the boat. A modern production facility was set up, with all crew, including Walton, getting gritty on the shop floor. As sales increased, it was enlarged to 27,000 sq ft (2,511m^2).

From the Corsair website: "Everyone pitched in no matter how dirty the job, and no one was exempt. Even John, one of the wealthiest men in America, was in the thick of some of the worst grinding jobs, was a great laminator, and the main instigator of the extensive vacuum bagging systems that were developed at Corsair over the next few years. It was a good combination all round. I had the design and ideas for a radically new boat with my patented folding system, John had the capital to see it through the very difficult and unprofitable development stage, and we had a great crew. The F-27 could not have had a better start. Vacuum bagging complete hulls, with outer laminate, core, and inner laminate being bagged simultaneously, was one of the big advances developed at Corsair. Total lamination time for this hull was 1 hour and 30 minutes (45 minutes each side). No one could do it quicker or better." Farrier said the boat comprised 57 individual molds.

Billed as a family cruiser that is also fast, the F-27 won races and in 2004 became only the second multihull (after the Hobie 16) to be inducted into the American Sailboat Hall of Fame.

Farrier resigned from Corsair Marine in 1991 to pursue other designs, including the F-31 (9.4m), and later, the F-22 (6.7m), which at the time of his death he'd been working on to increase production. During the years Farrier was busy making tooling for the F-22 and setting up the shop for the new model, he and I corresponded regularly. I hoped he'd write a Design Brief for this magazine, and he continually protested he needed to make more progress before he could slow down long enough to write.

Old friend Peter Hackett sent this memory via Sackville Curie, an early dealer of Farrier boats: "My first association with Ian was as a pimply teenager in Hawthorne, Brisbane, 1973. A couple of Kiwis had moved into a house [across]


COURTESY SACKVILLE CURIE

Ian Farrier, who died in December 2017, was a passionate advocate for multihull hullforms. His clever folding mechanisms enabled his smaller designs to be towed behind the family automobile. He hoped that the F-22 (6.7m), which he was working on day and night at the time of his death, would be affordable for middle-class sailors.

the road, and not long after, a plywood thing started growing under the house and then emerging into the yard. To us Aussie/monohull/dinghy people, our first guess was that it was a caravan. When I tried to convince my carpenter/boatbuilder father that it was starting to look like a boat, he just laughed. Not long after that, my curiosity got the better of me, and on the way home from school I diverted and had a sneaky look over the fence. There was a guy under the house laboring in one of our typical warm summer afternoons, covered in sweat and glue. I asked if I could come in and he downed tools in the most welcoming way to explain to me what this strange craft was. In a scenario to then be repeated thousands of times around the world by various methods and media, Ian Farrier shared his dream with me of safe, cheap, and fast multihull sailing for the masses. I was skeptical at first, but when he showed me his detailed plans I was starting to get quite excited. Then he produced a model cut out of the walls of a can with nails for pivot points. It demonstrated that with pairs of struts balancing the forces involved, this multihull trimaran with no lead keel could be trailed behind a family car to all sorts of dream locations, then sailed safely and quickly in all sorts of waters."

And from Rob Densem, general manager of Farrier Marine in Christchurch, New Zealand, to www.sailinganarchy.com: "Ian was a visionary, a multihull genius, an all-round nice guy who leaves behind a huge legacy to the sailing world. Farrier Marine Limited is a strong business with a three-year order book for the revolutionary F-22 sailboat. Despite dealing with our grief, it is very much 'business as usual' at the factory today. It is our job now to carry on the Farrier legacy and ensure his vision is carried out." —*D.S.*

PBB

FOILING: PART 1

Rising to the Occasion

BY DIETER LOIBNER

DENISE LARSEN

Harry Larsen put the throttle down, and *Talaria IV* was on the move. A bit ponderously at first, as one would expect of a 24′ (7.3 m) cabin cruiser with 5,140 lbs (2,331 kg) of displacement still powered by her original 200-hp Volvo Penta 280 sterndrive, she picked up speed and skipped past 30 knots—a good hustle for a 1980s-vintage Bayliner Monterey. At that cruising speed, I saw Quartermaster Harbor on the southeastern end of Vashon Island, Washington, quickly shrink in the distance. Shockingly, this happened without any spray splashing out from underneath the hull and no wake behind us. Only the frothy line of the prop-wash was neatly etched into the blue of Puget Sound.

But overall, I was disappointed by the lack of spectacle: "Really, that's what foiling feels like?" I thought. I'd expected the driver to flip a battery of switches or push one magic button. But Larsen just sat there as if he'd been driving his station wagon, while *Talaria* did it all by herself. As we zoomed along, it slowly sank in: It's the absence of drama that's the real story here. By making his quirky prototype foil, Larsen pulled off a tough act and made it look easy. So easy, in fact, that I came away wondering: "If *this* boat can foil, well, pretty much any boat should, too."

So why don't we see more powerboats cruising along smoothly at 30+ knots, with

DIETER LOIBNER

Top—Talaria IV*, a vintage Bayliner Monterey, cruises along the shores of Vashon Island. Owner Harry Larsen, at the helm, conceived and installed the 24′ (7.3m) boat's retractable foils, arranged in a canard configuration.* ***Above***—*When foiling,* Talaria *leaves a narrow wake consisting only of the prop-wash.*

Advances in foil design, construction materials, and networked ride controls have led to a renaissance in hydrofoiling.

foils in the water and hulls in the air? Is foiling "a solution looking for a problem," as someone quipped, or is there a "killer app" on the horizon that will turn foiling powerboats into a common sight?

Having worked on cutting-edge America's *Cup designs, Paul Bieker of Bieker Boats in Seattle, Washington, also applies his knowledge of efficient foil design to smaller craft.*

Foil evolution

Let's revisit some of the intriguing benefits foiling offers. For one, it avoids the bumps we know from hullborne boats. It also drastically reduces drag, which means the boat can go faster and/or farther on less power. Ideally, this translates into fuel savings (because hydrofoils have a much bigger lift/drag ratio than planing craft) and lower emissions of carbon dioxide and nitrous oxide, two contributors to climate change and respiratory diseases. And as *Talaria* showed, foilborne operation virtually eliminates wake, which helps sensitive ecosystems and creaky infrastructure along waterfronts. But there's one huge challenge: balancing those benefits against the cost of building exotic one-off boats fitted with complex foil-control systems.

While the technology has been the subject of a lot of press lately about myriad high-tech foiling sailboats (i.e., the Moth dinghy, numerous multihulls including the *America*'s Cup catamarans and Open 60 keelboats in the Vendée Globe), the underlying principles have been well understood for a long time. Powered hydrofoils have been around for more than a century, and during the Cold War, militaries poured time and money into developing foilborne warships. While the idea of foiling frigates never played out as envisaged, the research and testing yielded troves of data and knowledge that remain relevant today as boat designers and builders strive to bring foiling boats into the mainstream.

Early foiling craft were comparatively heavy brutes built from aluminum, with steel foils. Their designers quickly ran up against the horsepower requirements to fly these already heavy vessels, adding weight that called for even more horsepower. Advances in construction techniques, composite materials, and propulsion technologies solved some of these problems. Resin-infused carbon fiber cured in an autoclave oven for minimum weight and maximum strength changed the power-to-weight equation remarkably. Lighter boats need less power and become foilborne much quicker. Today, even pedal-powered craft can lift off at speeds as modest as 6 knots. On the control-system side, faster, smaller, and cheaper computers further improved performance.

Modern hydrofoils also owe a lot to the designers and engineers who developed those light hulls and effective foil sections and shapes (i.e., for boats that have very limited power to get foilborne), using computer-aided design (CAD) software like Rhino and programs for finite element analysis (FEA) and computational fluid dynamics (CFD) that allow for more accurate modeling and performance predictions. Advanced production methods that rely on 5-axis computer numerical control (CNC) routing machines and 3D printing of molds and parts also help produce those state-of-the art hulls and appendages.

Surface-piercing foils were standard for decades, because they were relatively easy to build, offered inherent height control—as lift reduced when a boat rose farther from the water—and provided lateral stability with a broad foil span that extended beyond the hull. Now, computers that work reliably in a marine environment coupled to sensors and hydraulic controls make it possible to fly a boat on fully submerged foils of an inverted T-shape that extend beneath the surface to where the water is less disturbed. Small sailing dinghies like the Moth or Dave Clark's UFO (see "The People's Foiler," *Professional BoatBuilder* No. 166) are good examples of T-foil applications.

For a long time, the so-called airplane configuration dominated hydrofoil design, with the main foil(s) forward and small stabilizing foil(s) under a narrow stern. This works well on boats with a forward center of gravity. Beginning in the late 1950s, the so-called canard system gained traction. It puts one foil forward to support the bow, to initiate turns when foilborne, and to control foiling height; the main foil aft carries most (70% to 80%) of the boat's weight and provides lateral stability and roll authority.

Control systems

The third major factor determining hydrofoil performance is motion and ride control. The wilder the water and the smaller the craft, the more challenging the task. Small sailboats rely on passive control via foil shape (the Olympic Nacra 17 foiling catamaran or the A-class catamarans), or active mechanical controls where a wand determines the foils' angle of attack and the hull's elevation above water. (For more on wand controls and the development of sailing foilers, see "Takeoff Window," PBB No. 139.) While simple and cost-effective, such systems require user input and response, which is not as smooth and consistent as a computer programmed to manage pitch, heave, yaw, heel, and elevation based on the inputs from sensors—gyroscopes, accelerometers, IMUs (inertia measuring units), radar, optical or acoustic sensors, knotmeters, GPS, and positioning sensors. It's easy to imagine that modern foiling boats are destined to operate less like conventional boats and more like airplanes, though the latter have thousands of feet of altitude to play with, while a foiling boat has but a few inches or a couple of feet at most.

"Complete (optimal) control is not possible with a mechanical system that is based on angle input or visual input from the operator," said Chris Pappas, an engineer at Naiad Dynamics, a U.S. company that develops and implements stabilizing and control systems for large military and commercial vessels. "The analogy is fly-by-wire systems used on airplanes today. The pilot moves a stick, but the computer is correcting to steer the plane in the direction requested. A human cannot sense rate, because by the time he is feeling a change in attitude (angle), the motion has already occurred, while computers can use the rate and acceleration input from a sensor and do the math to provide a solution." Pappas's sentiment is shared by Paul Bieker, a Seattle-based yacht designer who has been instrumental in all of Oracle's *America*'s Cup campaigns. "Once you go to a fly-by-wire control system, input and output is controlled by data bus. [For optimum performance], you'd have to eliminate mechanical control types and human interaction," he said. "Control really is a software issue. It's a programming problem."

> "Control really is a software issue. It's a programming problem."
> —*Paul Bieker*

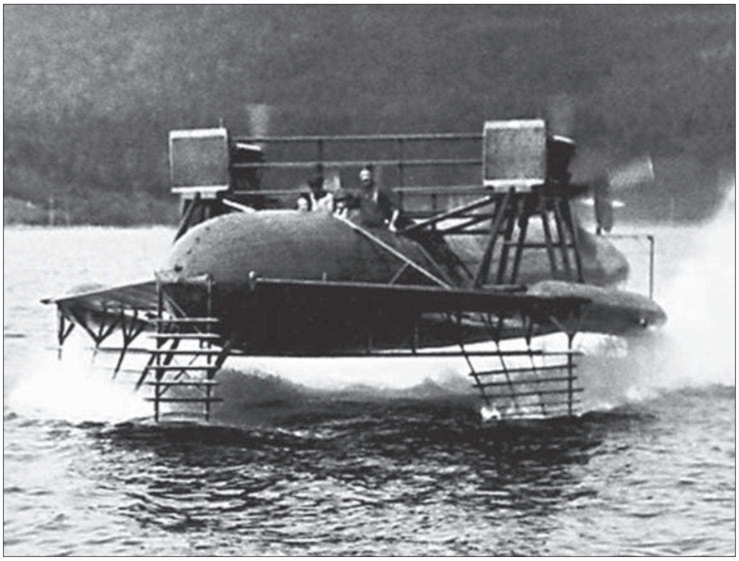
COURTESY FOILTWISTER

Designer Alexander Sahlin drives an early prototype of the Swedish Foiltwister. It uses mechanically controlled foils, including a wand at the bow to manage foiling height.

The pioneers

Air and water are fluids with vastly different densities. A foil running through them produces lift based on similar principles—Newton's Laws of Motion and the Coanda effect. It's not surprising that many flight pioneers in the early 20th century also experimented with hydrofoils. In Italy, Enrico Forlanini, an aeronautical engineer, was perhaps the first to achieve full flight on ladder foils in his surprisingly modern-looking craft *Idrottero*, which zipped across Lago Maggiore at 37 knots as early as 1906. Photographs reveal that he experimented with various propulsion systems, including two counter-rotating air screws and a strut-drive that extended downward into the water about amidships to drive a propeller. In the U.K., John Thornycroft used foils to boost speed in his designs.

On the U.S. side of the Atlantic, brothers William and Larned Meacham tested hydrofoiling concepts during the first decade of the 20th century, including a surface follower that acted as a height sensor. They applied for and received several patents for their work, which they called, strangely enough, a *hydroplaning* boat. Inventor Alexander Graham Bell and his partner Frederick W. "Casey" Baldwin experimented with stacked kites and hydrofoils on the Bras d'Or Lakes in Nova Scotia. After meeting Forlanini in Italy in 1911 and getting a ride on his foiler, Baldwin designed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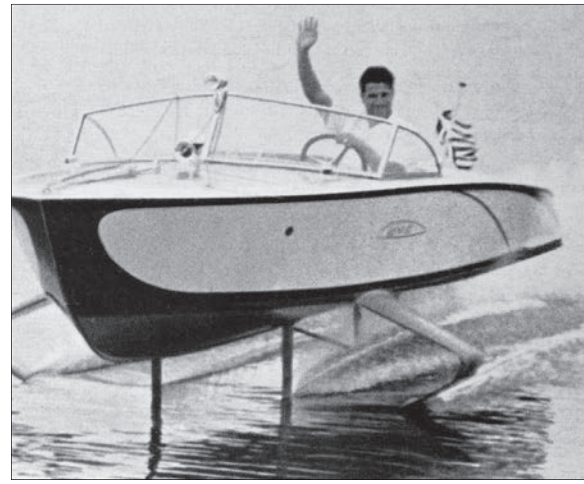
WING BOAT MARKETING BROCHURE


WIKIMEDIA COMMONS

Above—*The record-setting HD-4, designed by Alexander Graham Bell and Frederick W. Baldwin, reached 61.6 knots in 1919, a world speed record at the time.* ***Above right—****In the 1950s, the German-built Wing Boat was an avant-garde water toy for Aristotle Onassis.* ***Right—****Italian inventor and designer Enrico Forlanini, shown here foiling across Lago Maggiore circa 1910, was ahead of his time—and his peers.*

the "Hydrodromes," a series of foil-borne craft culminating in the cigar-shaped HD-4 with four sets of ladder foils, launched in 1918. Initially this vehicle displacing 5.5 tons was powered by two Renault aircraft engines, but the breakthrough performance came when Baldwin installed two 12-cylinder, 350-hp [261-kW] Liberty power plants, on loan from the U.S. Navy, that drove counterrotating air propellers. On September 9, 1919, the HD-4 set a world speed record of 61.6 knots, despite having struck a wooden crate that damaged the foil system on a test run beforehand.

Prior to World War II, German foiling pioneer Baron Hanns von Schertel successfully tested a prototype with tandem surface-piercing foils, and later developed foiling craft for Hitler's Reichsmarine. German newspapers reported on experimental vessels with jet engines and speeds of 64.8 knots, but it seemed none played a role in battle. After the war, von Schertel emigrated to Switzerland to start the company Supramar AG, which launched the first foiling passenger ferry, *Freccia d'Oro* (Golden Arrow), on Lago Maggiore in 1953. Supramar licensed the technology to international builders including Leopoldo Rodriquez Shipyard in Italy, Hitachi Zosen in Japan, and Vosper Thornycraft in England.

It is worth noting that Karl Vertens, a German yacht designer and contemporary of von Schertel's, who also was in the employ of the German military during WWII, later built the Wing Boat, a 21′ (6.4m) foiling plywood runabout powered by a 90-hp or 131-hp [67-kW or 98-kW] inboard engine. No German could afford such a boat then, but Greek shipping magnate Aristotle Onassis could.

During the Cold War, the Soviet Union developed numerous foiling vessels for military and civilian use. Led by the inventor and designer Rostislav Alexeyev, foiling passenger-ferry models such as Raketa, Meteor, and Voshkod were built. Modern versions are still in service in Russia and Eastern Europe.

The U.S. Navy gets serious

In 1953, William P. Carl, the designer of the P-38 Lightning aircraft, put two airplane engines on a 53′ (16.2m) experimental craft called XCH-4, which is said to have exceeded 65 mph (56.5 knots) in open water, and from afar was mistaken for a seaplane. A 1959 article in *Popular Science* included sci-fi sketches of 100-knot passenger ferries and nuclear-powered ocean liners on hydrofoils. But in the real world, the boat that embodied a real advance in foil technology was called *Sea Legs,* a small Chris-Craft cabin cruiser with fully submerged foils arranged in a canard configuration and actively controlled through an analog computer with vacuum tubes.

In 1962 Boeing built a 110-ton prototype foiling patrol craft for the U.S Navy, the *USS High Point (*PCH-1), which featured fully submerged

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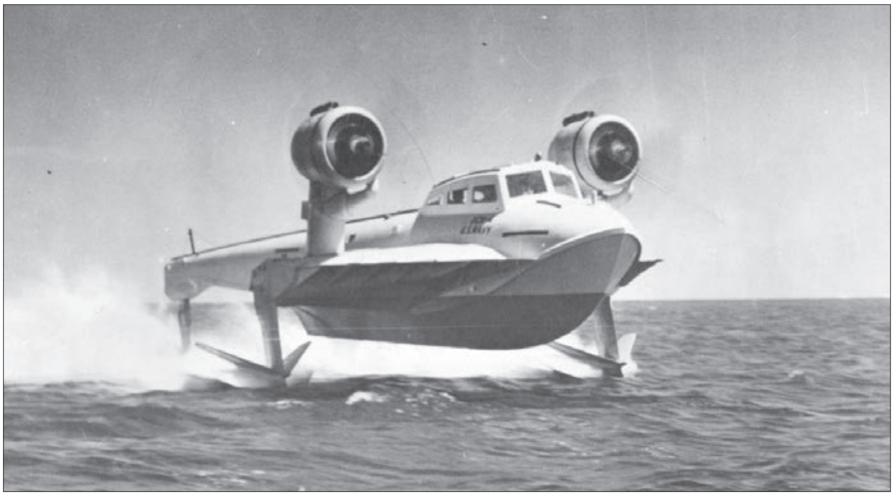

WIKIMEDIA COMMONS

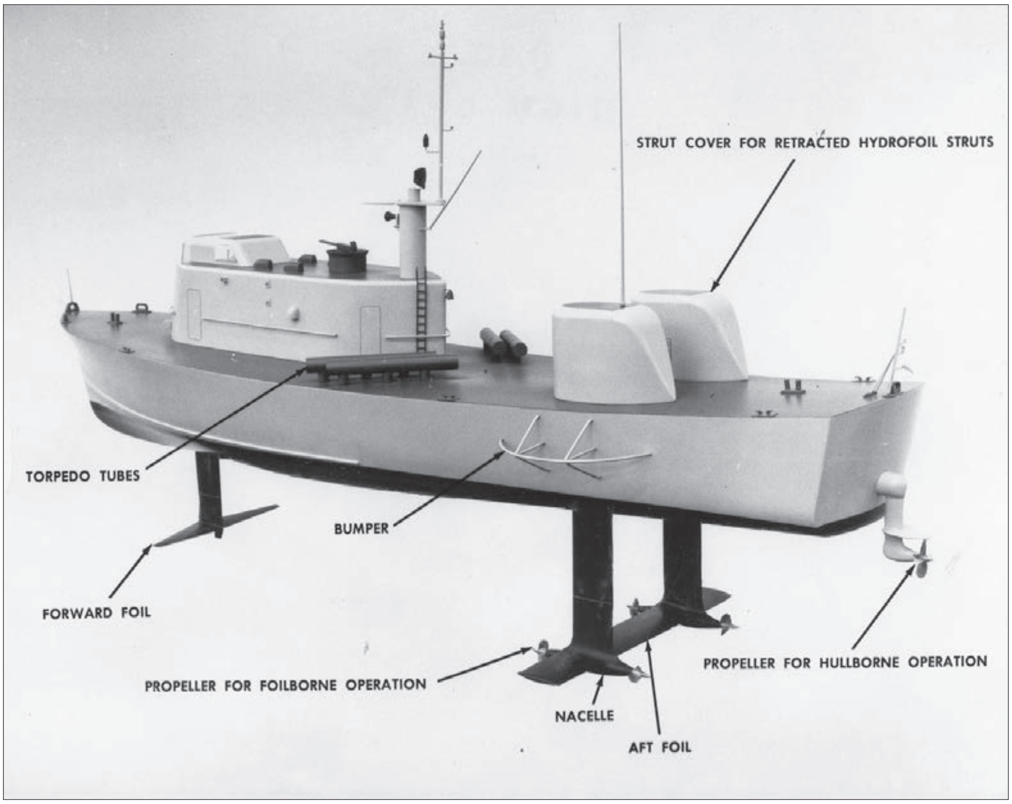
William P. Carl conceived fast planes and vessels. In the 1950s, the designer of the P-38 Lightning aircraft followed Bell's and Baldwin's lead, putting two aircraft engines on the experimental XCH-4 (aka the Carl Boat), shown here on an ocean test run.

retractable foils. Foilborne operation relied on propulsion nacelles with four propellers on the aft struts, while a steerable outdrive was used in displacement mode. The advantages of this system included higher efficiency and better seakeeping in rough weather, but the system needed sophisticated controls to operate the vessel safely and effectively.

Still, the Navy envisioned hydrofoiling ships as part of its Cold War arsenal, awarding two contracts for hydrofoiling gunboats. Grumman delivered its *USS Flagstaff* (PGH-1), with an airplane foil arrangement, while Boeing chose a canard foil arrangement and waterjet propulsion for the *USS Tucumcari* (PGH-2). Also in 1965, Lockheed went really big with the 320-ton *USS Plainview* (AEGH-1).

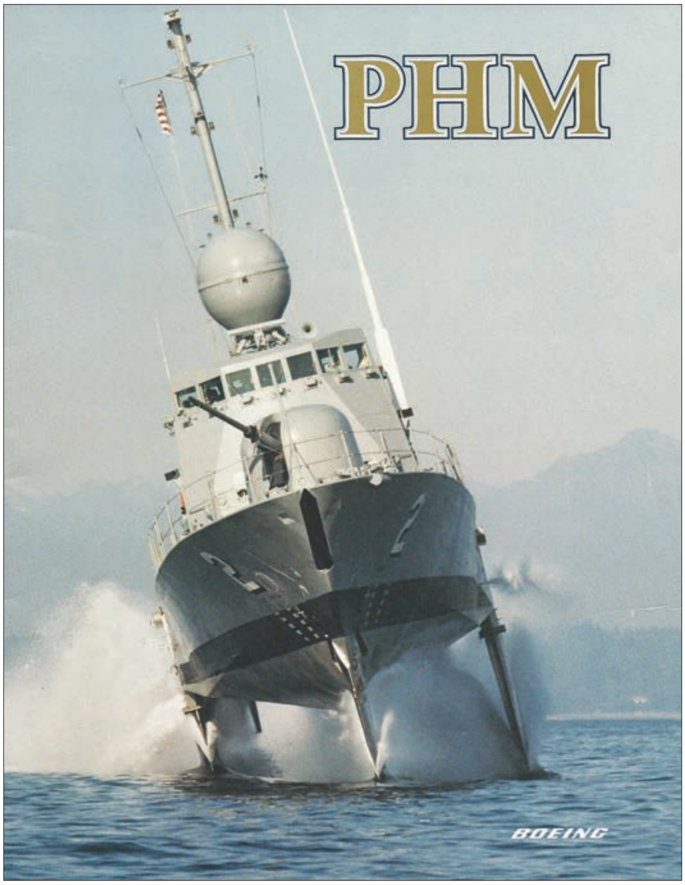
In the early 1970s, Boeing received the order to develop fast attack patrol boats of the Pegasus Class (also called PHM for Patrol Hydrofoil Missile) for operation in coastal waters and to counter Soviet and Warsaw Pact missile boats. But funding became problematic as the navies of other NATO countries opted out, so Boeing built only six of these formidable high-tech vessels. They were 133′ (40.5m), carried a crew of four officers and 17 enlisted sailors, and were armed with eight Harpoon surface-to-surface-missile launchers and an automatic 76mm gun. They had two waterjet propulsion systems: one for hullborne operation at speeds up to 11 knots, consisting of two MTU diesels with 1,600 brake horsepower; and another for foiling, powered by a General Electric LM-2500 gas turbine engine with 18,000 shaft horsepower.

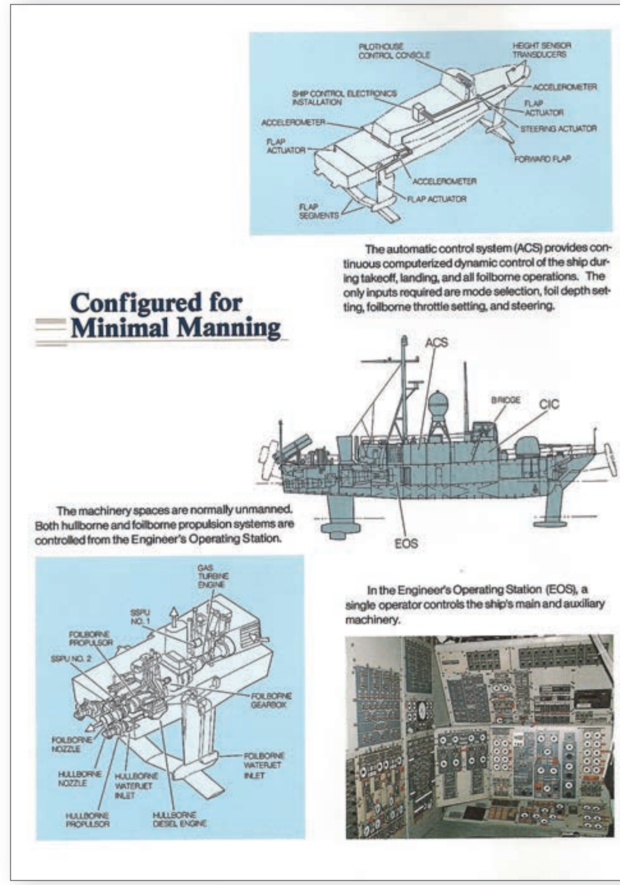
"The foilborne control systems were adapted from airplanes and used radar sensors to control the ship's flying height," explained Mark Bebar, a naval architect employed by the Naval Ship Engineering Center (NAVSEC) who worked on the PHM program in the 1970s. "These ships were capable of operating in 10′ [3m] waves at a foilborne speed of 48 knots with root mean square vertical accelerations [RMSVA] of less than 0.25 g in the wheelhouse, which was required by the ship specifications," Bebar said.



U.S. NAVY

The USS High Point patrol vessel with retractable foils in canard configuration was launched in 1962. Note the different propulsion systems for foiling and hullborne operation.





BOEING MARKETING BROCHURE (BOTH)

Boeing's brochure shows the sensors and control systems, based on analog computers, at the heart of the formidable PHM vessels armed with missile launchers and a 76mm gun. Only six were built, and they ended up on drug-interdiction missions for the U.S. Coast Guard from their base in Key West, Florida.

The squadron of PHMs was stationed in Key West to run drug interdiction operations for the U.S. Coast Guard. Despite their reliablilty and performance, all PHMs were decommissioned in 1993. Five were broken up, and one, *USS Aries* (PHM-5), survives as a privately owned museum exhibit.

From Jetfoil to Bayliner

All that military R&D didn't go to waste. Based on the canard foil configuration of the PHMs, the Boeing 929 Jetfoil, a passenger ferry for civilian use, was debuted in 1974 by Boeing's Marine Division. These massive vessels proved that foiling technology and waterjet propulsion could scale up to a size that made commercial sense. Nearly 50 of these Jetfoils were commissioned for service until the mid-1990s.

Displacing between 110 tons and 115 tons, they carry from 167 to 400 passengers. Some ran in the Hawaiian and Canary Islands and crossed the English Channel, but they chiefly serve Asian markets.

Back on Puget Sound, *Talaria IV* also runs on a canard foil system

WIKIMEDIA HONG KONG

The Jetfoil 929, a hydrofoiling passenger ferry with waterjet propulsion, was also developed by Boeing Marine Systems. Nearly 50 units were built, and most operate in Asian markets.

installed by owner Harry Larsen. He is an applied mathematician who worked at Boeing for three decades, including 10 years at Boeing Marine Systems. But he'd been interested in foiling technology long before. A 1966 graduate of the University of Washington, he sailed competitively and experimented with a 14′ (4.3m) foiling skiff powered by a 25-hp outboard before acquiring his used Bayliner Monterey in 1990 as a trailerable test boat. He'd taken courses in control systems at Boeing and taught himself composite construction and hydraulics. His personal project of making an old Bayliner take flight encompasses all the same challenges modern hydrofoil developers have to confront—weight, power, foil design, and ride control.

Lessons from *Talaria IV*

Larsen grew up on Vashon Island, where his parents operated a small shop called Skippercraft, which produced skiffs and powerboats. The business is gone, but the facilities still stand and now serve as an apartment building with boat storage overlooking a marina with a 30-ton Travelift. That's *Talaria*'s home base. My question for Larsen was, of course, why go to such lengths with such an old boat? "Foiling is fun," he answered over lunch. It also allows him to "get there in time" when it's choppy, because his boat flies above the waves while conventional craft pound and slow down. "I picked the Bayliner because it was the smallest suitable boat available at the time," he explained. "I needed a boat with an inboard engine to power the hydraulics for the control system."

At Talaria's helm, Larsen mans the wheel and throttle while watching sensor data on the monitor in the dashboard.

He built the foils and fitted *Talaria* with an arsenal of sensors for roll authority, turn control, pitch, and speed and added hydraulics for controlling and retracting the foils. He also had to extend the shaft of the outdrive by 3′ (91cm) to keep the prop immersed when foiling. *Talaria* first took flight in 1992, relying on a surface-skimming plate that projected forward 3′ from the bow strut, using a four-bar linkage. It was attached to the bow foil, changing its angle of attack as a function of the boat's height above the water surface. Piercing a steep wave, not riding over it, the skimmer angle remained small, causing the foiling boat to power through the wave as well. This prevented the bow foil from flying out the far side of the wave with potentially disastrous results but caused a big splash as the bow encountered the next wave. Overall, the system worked well, including the analog computer Larsen initially used to control roll authority.

In 2008, after making many refinements, Larsen was ready to go digital.

DIETER LOIBNER (BOTH)

On this vintage yard dolly, the Bayliner with foils is even more odd to behold. But the folding mechanisms Larsen installed enable the boat to fit on a trailer with elevated bunks for road transport.

A view of the stern reveals the extension of the outdrive shaft, which keeps the propeller submerged when foiling, and Talaria's *anhedral rear foils.*

Talaria's 133-MHz, 64-bit CPU is an industrial computer with the necessary interface capability. It's a SBC0489 from Micro/sys, with a total of 16 channels of analog-to-digital converters (ADC), 1-MB flash memory, four channels of digital-to-analog converters (DAC), a RS232 interface, VGA screen driver, and a floppy disk port. While executing the flight-control software and displaying the control system's parameters on a 10″ (254mm) sunlight-readable LCD screen in the cockpit, the update speed is 75 Hz.

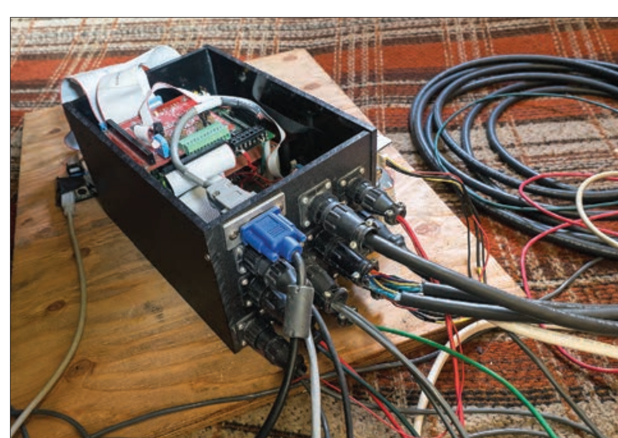
Larsen programmed the computer with 1,500 lines of code in C++. About half is reserved for the display, the rest for the control algorithm and interfacing subroutines. A Borland C++ 5.02 compiler generates the executable code, which is transferred to the SBC0489 flash memory through its floppy drive. And here's where it gets a bit more academic: Larsen derived the control law using the Linear Quadratic Regulator algorithm coded in Visual Basic. Its control gains vary with speed. The differential equation of height is:

$$ddh/ddt = k^*(\alpha - (dh/dt)/v) - g$$

where h = height; α = angle of attack measured from the zero-lift angle relative to the boat's coordinate system; k = the bow foil's lift slope; g = the gravitational constant; and v = velocity.

Using Xfoil, a free software for subsonic airfoil development, he designed and built a new aluminum bow strut, carbon fiber bow foil, aft foil, and side struts. He also added a foil-position sensor, an rpm sensor, a new bow foil actuator, a servo valve/manifold, and electronic interface to the computer. The actuated bow foil is operated by hydraulics with a custom-built throw cylinder and a fast Rexroth high-performance servo valve that opens fully in 10 milliseconds.

To measure the distance from the gunwale to the water, which determines foiling height, Larsen added two Senix Toughsonic 14 ultrasonic sensors, which he installed in the bow at 15° angles. An ADXL 203 accelerometer is also mounted in the bow, while the impeller for the knotmeter



DIETER LOIBNER (ALL)

Left—*The custom-programmed LCD monitor displays vital data including speed, rudder angle, roll rate, and foiling height.*
Right—Talaria's *"brain," an industrial 133-MHz, 64-bit central processing unit, sits unceremoniously on the aft bunk, surrounded by coils of cables.*

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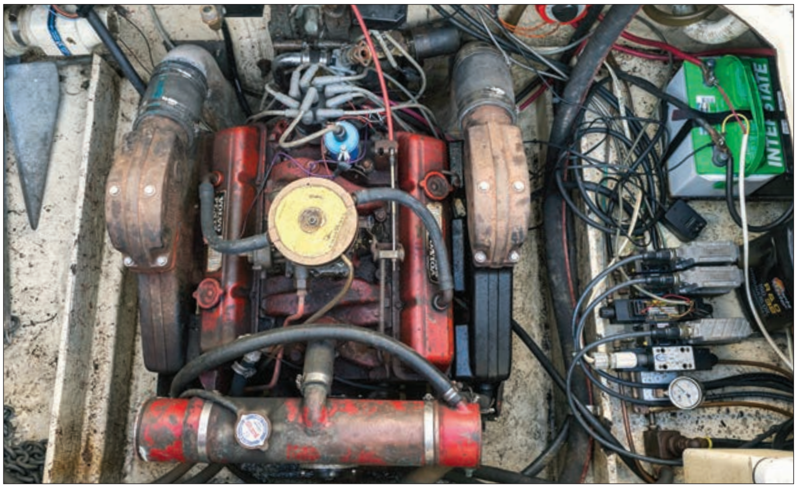


DIETER LOIBNER

DENISE LARSEN

Above—*The original Volvo Penta 280 power plant handles* Talaria's *propulsion and operates the hydraulics. The three Rexroth servo valves (gray cables) and the two valves for retracting the bow and stern foils sit on the hydraulic manifold.* ***Right***—*The original bow strut and the old fiberglass foil, shown here, were later replaced with a carbon fiber version.*

sits at the other end of the boat, at the bottom of the aft foil's center strut. It tells the computer the speed through the water, which is used to adjust the aft foil's flying height.

Larsen's complex combination of hardware and software is de facto the boat's brain that handles all the foiling controls, so the driver has to worry only about the wheel and the throttle. The steering is precise, with a maximum bank angle in turns of about 20°, and she tops out at 38 knots with the throttle wide open. That's nearly 40% faster than what the boat managed before foiling. Compared to the old mechanical flight control, "the ride is smoother now, and *Talaria* maintains constant height across foiling-speed range," Larsen said.

Takeoff speed is approximately 18 knots, and she's fully foilborne at 3,000 rpm. According to Larsen's math, the engine uses approximately 4 hp (3 kW) to run the hydraulic pump for the actuators. But what if…the engine dies? "The software monitors rpm, and if it falls below 1,500, it sets the boat down in controlled fashion to avoid hurting people on board," he said. The prospect of collisions with UFOs (unknown floating objects) does not faze him. "In 25 years of foiling, I hit many smaller pieces of wood that caused no problems. If I ever hit a log square with the strut of the canard and the foil going under it, [the assembly] would shear off at the pins that attach it to the steel plate on the stem. And it's similar with the main foil aft."

All told, that is a lot of technology, but even on this short outing in the waters of Vashon Island *Talaria* proved how it works and why foiling is fun. In our next issue we'll look at the latest crop of powered hydrofoils, some pretty conventional, others more futuristic. A few are already on the water, while most are still in various stages of development. But all of them prove that given the right design and build, almost any boat can rise to the occasion. PBB

About the Author: *Dieter Loibner is an editor-at-large of* Professional BoatBuilder.

Some Sources

Full Wiki: http://www.thefullwiki.org/Hydrofoil.

Vellinga, Ray. *Hydrofoils: Design, Build, Fly*, Peacock Hill Publishing, 2009.

Mantle, Peter J. *High Speed Marine Craft: One Hundred Knots at Sea*, Cambridge University Press, 2015.

"Controlling the ride height of hydrofoiling boats in Ranse CFD": http://www.oossanen.nl/beheer/wp-content/uploads/2015/02/029-Bergsma-et-al-v2.pdf.

Popular Science, March 1959: 100-knot Liner to Fly on Sea Wings.

Popular Science, July 1961: Sea-going Hydrofoils Do 60 Knots, International Hydrofoil Society.

What Grows in the Darkness of Diesel

From taking samples and cleaning tanks to arming with biocides and/or biofilm dissolvers, here are strategies to help captains and service yards fight contaminated diesel.

Text and photographs by Nigel Calder

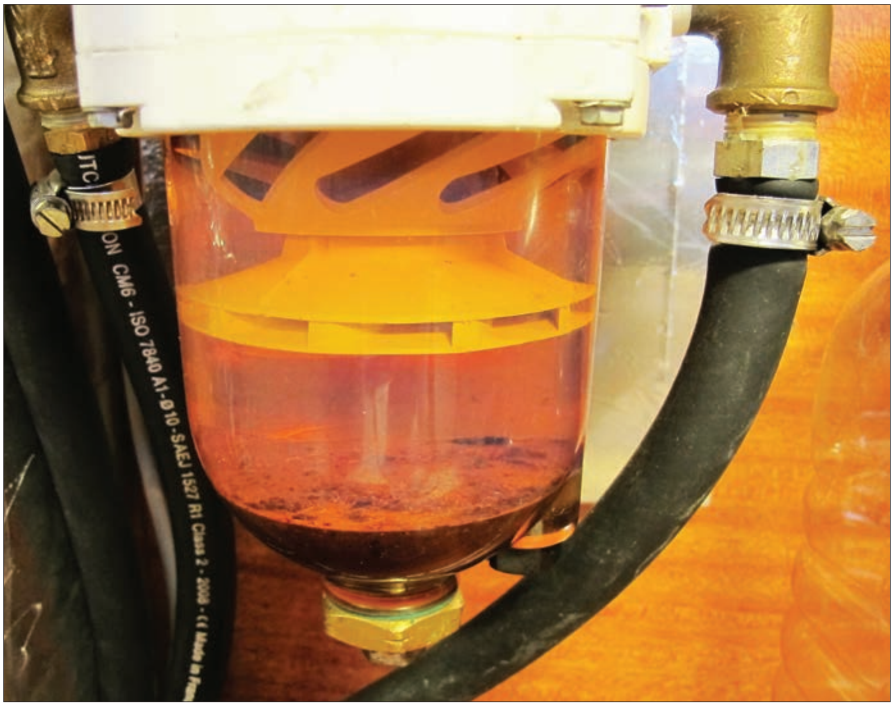
Twice in recent years we have taken on board seriously contaminated fuel, both times at "high-end" marinas—one in Sweden and the other in the United Kingdom, the latter immediately after the marina had spent two weeks cleaning and flushing its fuel tanks and fuel-delivery systems. My experiences led me to do significant research into preventive measures to ensure that I don't get fouled again.

I found that fuel contamination is, unfortunately, not uncommon, and possibly a result of changes in worldwide fuel supplies. These changes include the removal of sulfur from diesel, resulting in today's ultra low sulfur diesel (ULSD), and the increasingly common addition of a "bio" component to the fuel, including in the United States. In 2015 the Environmental Protection Agency's (EPA) limited sampling of diesel storage tanks across the nation found a biodiesel component in 70% of them. Note that biodiesel is added as a lubricity enhancer, typically in quantities of 1%, to make up for lubricity lost in the sulfur-removal process for producing ULSD.

Multiple Problems

Biodiesel is a solvent, much as ethanol in gasoline is a solvent. If added to an old tank in higher concentrations, biodiesel is likely to dissolve all kinds of gunk off tank walls and add it to the fuel supply (see "Biodiesel," *Professional BoatBuilder* No. 116). I suspect that the fuel we took on in Sweden was the marina's first batch of biodiesel that had been delivered to the marina (see the **sidebar** on page 46). It dissolved the gunk out of their tank and deposited it in ours, plugging not just our primary filter but also all the lines between the tank and filter. The fuel

Above—*If primary fuel filters look anything like this, opening up the fuel tank and thoroughly cleaning it out is long overdue.*



Fuel in a primary filter should be absolutely crystal clear (although colors may differ according to diesel blends and added dyes). Any opaqueness is a sign of serious contamination that needs addressing. Note the accumulated water and sediment at the base of this filter. There is obviously significant tank contamination that requires cleaning up.

system had to be disassembled and cleaned and the tank opened and flushed—no small task (more on this later).

Biodiesel also has the capacity to hold significant amounts of water in suspension; petrodiesel does not. The fuel we took on in the U.K. was saturated with water. During six days of sampling, small amounts of fresh water dropped out each day. Biodiesel is a surfactant (surface active agent), meaning it breaks up the water into tiny droplets that are held in suspension within the fuel and small enough to pass through most water-separating filters. After six days spent dockside, we pumped the U.K. fuel out of our main tank, ran it through the marina's portable fuel-polishing system, and stored it in an auxiliary tank. I let it sit for two months and then sampled it for additional water that might have precipitated out. I pulled almost 2 gal (7.6 l) of water off the bottom of the 60 gal (227 l) of fuel in the tank (see the **sidebar** on page 40).

But perhaps the biggest problem with the combination of ULSD and biodiesel is the favorable environment it creates for microbial proliferation. ULSD removes a naturally occurring antimicrobial agent at the same time as the bio component promotes microbial growth. This growth can not only plug fuel systems and degrade fuel quality, but it can also foment microbiologically influenced corrosion (MIC) in metal tanks, including stainless steel tanks, and on metal components in the fuel system. (For more on diesel quality and chemistry, see "So You Think You Know Diesel," PBB No. 115.)

The author and his wife have at times taken on fuel from various potentially dubious sources. In this case, she's getting fuel from a lighthouse off the Yucatan coast of Mexico.

Although the microbes are primarily found in diesel and aviation fuel, they can also be in gasoline, especially with the increasing levels of ethanol and other biofuels.

Microbial Processes

A wide variety of organisms can do damage. These are often incorrectly referred to as algae, but for photosynthesis algae require light, which typically is not present in fuel tanks. The rule is simple: no light, no algae. Instead, more than a hundred different strains of bacteria, fungi, and mold *can* exist in the fuel in a planktonic (individual) form or in a biofilm, with bacteria being the most common. Some of these bacteria are aerobic, meaning they need oxygen to survive (oxygen is frequently present in diesel, especially after the turbulence caused during refueling); and some are anaerobic. Aerobic and anaerobic bacteria can coexist in a symbiosis in which the aerobes consume oxygen, creating a local environment in which anaerobes then thrive.

The coexistence of different microbes is known as a consortium. The bacteria initiating surface biofilms generate a starchlike substance, often referred to as slime, which houses the consortium. The slime can be a thin film on the sides of tanks, or it may be in the form of fuel sludge on the tank bottom. Biofilms can also break off and form floating colonies. A consortium produces a microenvironment with a complex food chain in which bacteria multiply more or less impervious to conditions in the rest of the tank.

Within a consortium we may have bacteria that metabolize hydrocarbons and in the process create chemicals that other microbes can use. The hydrocarbon-utilizing bacteria in the colony break down certain hydrocarbon molecules, resulting in unstable remaining hydrocarbon molecules. These react with other unstable molecules to form microscopic solid-hydrocarbon particles. These can agglomerate into larger filter-blocking particles commonly referred to as asphaltenes, which look like coffee grounds. Note that asphaltene is a naturally occurring contaminant in crude oil, and may be present even without biological contamination. These solid fuel particles, combined with water, bacterial slime, and inactive bacteria, drop to the bottom of tanks and form an anaerobic sludge that is fertile ground for further bacterial colonization. If the particles remain small enough to pass through filters, they can wreak havoc on fuel-injection systems, especially on injectors in high-pressure common rail (HPCR) engines.

Some by-products of the biofilm chemistry occurring in ULSD tanks are acetic and other organic acids. These acids are corrosive to metal fuel tanks and fuel systems. Other common bacterial by-products include surfactants, which add to the fuel's ability to hold water in suspension, frequently resulting in a cloudy layer of emulsified fuel at the bottom of a tank just above any "free" water (known as water bottom) in the base of the tank.

Above—*This sample of the fuel taken on board at a high-end marina in Sweden shows a likely combination of bacterial fouling and gunk broken loose from the marina's fuel tank by the biodiesel's solvent properties.* ***Right***—*A series of samples illustrates the progression of serious saltwater contamination from the base of a tank upward. The saltwater contamination occurred in heavy weather through a poorly sited tank vent.*

Water Is Life

Bacteria find the water they require for growth as condensate on the walls of fuel tanks, some dissolved in the fuel, and most abundantly as a layer of water on the bottom of many tanks. Some microbes inhabit the fuel side of the interface and some the water side. They can be brought on board in fuel supplies, or be carried in through tank vents on particles of dust or droplets of water vapor as fuel is burned and tank levels decrease, drawing in air. Further air exchanges occur when partially full tanks "breathe" with variations in ambient temperature.

Boat fuel tanks are particularly susceptible to water contamination, because, unlike in the automotive world, vents are typically open directly to the atmosphere, and the environment is especially humid. Sometimes I see poorly sited vents that can directly admit water when a boat is heeled a lot or waves are surging past.

The bottom line: Because the chemistry and processes by which microbes are introduced and reproduce are many and complicated, prevention and eradication are difficult.

Tank Sampling

The first line of defense against microbial contamination of a fuel tank is to keep water out and as quickly as possible remove any that gets in. To do this, the tank needs a defined low spot and a means to empty this low spot—either a drain, if the tank is set high enough in the boat, or a sampling/pump-out line set to within about an eighth of an inch (3.2mm) of the bottom of the low spot, with an attached manual or electric pump discharging into a hose with a shutoff valve.

I have had such a system on my boats for decades. My standard refueling procedure has been to take on fuel, let it sit for 10 minutes, and then pump a sample from the tank's low spot into a jam jar or similar container. If the fresh fuel is seriously contaminated, that's enough time for sufficient levels of contaminants to settle out and be clearly visible. If you find contamination, of course you must remove the fuel from the tank.

On a recent occasion, I had to pump contaminated diesel into plastic milk jugs and haul them to a boatyard disposal facility, 3 or 4 gal (11.4 or 15.1 l) at a time; it was an all-day exercise. I changed my refueling practices so now I first pump a small sample from the marina's outlet directly into a clear glass jar, and if this sample is not absolutely crystal clear, the fuel does not go in the boat.

The other practical function of the drain/sampling pump is to periodically remove the inevitable water that condenses out in any fuel tank over time and settles to the bottom. I do this every month or two that we are on the boat, and before first firing up the engine after a layup.

Killing Fields

Two categories of chemical treatments can be added to a tank to combat harmful microbes:

- biocides, which kill the microbes
- biofilm dissolvers, which disrupt the microbial colony, mitigating its associated problems

The U.K. Water Saturation

The marina had just cleaned and flushed its fuel-delivery system, making this an unusual case. We were the first boat to fill up after this, and were pumping fuel at the same time as the tanker truck was refilling the marina's tank. My guess is we got a load of water-saturated fuel from the bottom of the tanker truck. We detected it soon after, and I informed the marina. The sample they pulled from their tank came up crystal clear, and they claimed the contamination must have already been in our tanks. However, I had sampled our tank immediately prior to refilling to make sure there was no contamination, and their sample was not taken from the bottom of their tank, so was not a valid test. Even with a badly contaminated tank, the fuel at the top is likely to come out looking just fine. To be at all useful, samples should be taken only from the bottom of a tank. Fuel retailers and suppliers often drop a specialized device onto the bottom of a tank, where it opens to capture a sample, which is removed for testing.

Over the next six days I drew two small samples each day of less than half a pint (0.2 l) each from the bottom of our tank, one immediately after the other. The first would capture anything that had settled out since the previous day ("free" water), and the second any saturated layer immediately above this. Each day the first sample had a small amount of water, while the second was really cloudy but without any free water. By the following day, water would begin dropping out of the second sample. As mentioned in the main text, after six days we pumped the fuel through a fuel-polishing system into an auxiliary tank and let it sit for a couple of months, after which I pulled almost 2 gal (7.6 l) of water off the bottom of the tank. The remaining fuel was still cloudy, but no further water dropped out. I then dosed it with Fuel Right, and it slowly clarified over the next few weeks, at which point I put it in the main tank and burned it.

—*Nigel Calder*

Water-saturated diesel was taken on board in the U.K. ***Left to right—****The three samples represent the water that has settled out at the base of the tank immediately after refueling, 24 hours later (2-1), and then another 24 hours after that (3-1). The rate of water dropout decreased but nevertheless continued for weeks.*

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Biocides, the best known, are used widely in diesel and aviation fuel. Because they work in all hydrocarbons, they can also be applied to gasoline. However, it's not widely understood that these can actually worsen a problem. To be effective, a biocide needs to be deadly to all the various microbes that may be found in a tank, and must also reach all the microbes. Biocides get "used up" in the process of killing microbes and also lose their effectiveness over time. A partial kill rate with a subsequent decrease in the biocide's toxicity can lead to an intensified infestation, especially if the biocide has a nitrogen component, which can become a food for the bacteria.

Biocides are most effective against individual (planktonic) bacteria floating in the fuel, but they may have trouble penetrating accumulated slime, sludge, and biofilms. Consequently, the ideal way to use biocides is in a more-or-less clean tank, treating fuel as it is pumped in. Experience suggests that even in seriously fouled tanks, high enough doses of biocides will be reasonably effective over time.

Another issue can be problematic. As noted, some microbes inhabit the water side of the water/diesel interface and some the diesel side. To be effective, a biocide must be soluble in whichever side is harboring the microbes, or for a dual-phase biocide, in both sides of the interface.

Some biocides prioritize a "contact kill," whereas others focus on disrupting bacterial growth mechanisms. Although both may have components that are soluble in water and fuel, the contact killers tend to prioritize the water side and *act* faster, while the disrupters tend to prioritize the fuel side and *last* longer.

Ideal Biocides

We end up with these desirable biocide characteristics:

- Soluble in fuel and water
- A broad spectrum that has a high kill rate. In the case of a "shock" treatment, this is often recommended to be above 99% within 8 hours.
- The ability to penetrate biofilms and reach the embedded microbes
- Long-lasting efficacy, especially on boats infrequently used or seasonally stored, where the fuel may sit in tanks for months at a time. It is often recommended that the biocide remain effective for at least 8 weeks.
- Compatibility with fuel and additives. The biocide should not affect fuel stability, performance, or color.
- Compatibility with other system components, notably any rubber components and FRP tanks
- Safe handling. Biocides are obviously designed to be toxic to microbes; we need to ensure that they are

certified to have no health impacts on humans and, in particular, to look for registration with the appropriate government agency (e.g., the EPA in the U.S.).

Shock rates are typically recommended at around 3 oz to 4 oz of biocide per 100 gal (379 l) of fuel, with maintenance rates being half of that. Two popular brands are Biobor JF (www.Biobor.com), primarily a growth disruptor that has been in use since the 1960s, and ValvTect BioGuard (www.valvtect.com), which is optimized for a contact kill.

Because the biocide must reach all areas of the tank and fuel system that may be inhabited by microbes, it must penetrate biofilms, sludge, and slime. The ideal approach is to start with a waterfree, empty tank and to meter the biocide into the incoming fuel supply to ensure thorough mixing and dispersion. This metering is, of course, something most operators and fuel docks are not able to do. The recommended alternative is to half fill a tank, add the biocide, and then rely on the turbulence of filling the rest of the tank to mix the biocide and fuel. This will still not penetrate seriously fouled areas of the tank. If the fuel then sits in the tank for weeks and months at a time, as it commonly does, it is recommended to either give the fuel a shock dose when first put in the tank, or to add biocide periodically, every six months to a year, but in this case it will be even harder to achieve full dispersion.

Slime Dissolution

An alternative to biocides is to dissolve the biofilms that are the building blocks for microbial growth. The only chemical I know of that claims to do this is Fuel Right (www.FuelRight.com). Although that product has been used on several continents for a decade or more to treat millions of gallons of fuel, it lacks the level of evidence of its efficacy that biocides enjoy; their wide use for decades in billions of gallons of fuel has resulted in a wealth of evidence as to when and how they work or don't work.

While Fuel Right offers little independent third-party testing to recognized industry standards, it provides dozens of glowing testimonials, including from extensive testing by several shipping lines, but I am always skeptical of those. On the other side, a test by *Practical Sailor* magazine found accelerated fuel-tank corrosion. With some justification, Fuel Right strongly disputes the test protocol as inappropriate.

Fuel Right literature and numerous e-mail exchanges I have had with the principals explain its processes in terms of "micelle" formation and "filming amines," some of which dissolve the bacterial slime that holds bacteria together, and some of which


Right—*A seriously contaminated fuel sample drawn from the base of a fuel tank became clear* ***(far right)*** *after receiving a "shock" dose of Fuel Right.*

stop slimes from forming—the mix breaks up existing infestations and prevents recurrence. Because the amine coating on tank walls is electrically nonconductive and hydrophobic (impermeable to water), it forms a barrier to corrosion on metal surfaces. Note that recent EPA research in the U.S. into the increasingly widespread fuel tank corrosion since the introduction of ULSD specifically recommends filming amines as one of the measures likely to inhibit corrosion.

I have struggled to get my head around the chemistry, but it is well beyond me. So, over the past couple of years I have conducted experiments with Fuel Right, in particular applying it to the seriously water-contaminated fuel I received from the U.K. marina. I have to say the effect has, at times, been nothing short of astonishing. I have taken samples of fuel that were totally cloudy and opaque, given them a shock dose of Fuel Right, and watched the fuel become clear and translucent in a matter of minutes, with minor deposits dropping out to the base of many of the samples—although interestingly, on some there was no visible precipitation.

I have dosed my own tank, already visually clean from the thorough cleaning after the Swedish-fuel contamination, and seen my primary filter element, which normally looks more-or-less spotless at a filter change, come out contaminated with black sediment. Although biofilms themselves are nearly transparent, this was most likely evidence of residual deposits, the asphaltenes mentioned earlier, that were dissolved by Fuel Right. In more severe tank contaminations, Fuel Right claims that its chemicals will soften and clean out the deposits over time. It is also reported to significantly improve lubricity. The minimizing of asphaltenes, combined with other additives in Fuel Right, promotes cleaner-burning engines with fewer injector deposits, which is particularly significant for today's high-pressure common rail (HPCR) engines.

The fouling of this Racor primary filter element is from an ostensibly clean fuel tank treated with a shock dose of Fuel Right. The chemical has broken loose various deposits from within the tank.

Recognizing the weakness of my limited anecdotal evidence, I nevertheless have become a cautious believer and will in future give my fuel system maintenance doses of Fuel Right whenever I top up the tank.

Dose rates are similar to the biocides, i.e., a shock rate of around 3 oz to 100 gal of fuel, with maintenance rates being around 2 oz per 100 gal. So far as I have been able to determine, filming amines can be used with biocides, so a paranoid approach might be to use both.

Tank Cleaning

What if your tank has become seriously fouled? This is common on older boats, either from accumulated microbial deposits or simply from sediment

The Swedish Fouling

The Swedish fouling event I described in the main text forced me to clean our primary fuel tank. By initially removing the fuel-level sending unit, I had a 2″ (51mm) hole in the tank. Holding a wooden batten long enough to reach to the bottom of the tank, I felt around to identify the low spot, then duct-taped a PVC hose to the batten, connected the hose to a manual vacuum-style oil-change pump, and moved the hose around at the bottom of the low spot while someone else operated the pump. The duct tape was a mistake, because the diesel dissolved its adhesive, and the tube came loose, leaving the tape submerged in the tank. So now I had something else to fish for. I reattached the tube to the batten with a couple of plastic cable ties and tried again, but it soon became obvious that I needed better access to deal with the extent of the fouling, and in any case, how was I going to find the tape? Luckily, my tank has a substantial metal plate with all the suction and return fittings built into it. We removed this to create a large enough opening to manually reach into the tank and clean it out. —*N.C.*

In an unsuccessful attempt to pull contaminated fuel from the bottom of his tank, the author employed a suction tube duct-taped to a stick fed through a 2" (51mm) hole. That access proved too small to properly clean the tank.

buildup over time. How do you clean this out?

First, it might be worthwhile exploring the extent of the contamination. A new tool makes this relatively simple—an endoscope, or borescope, camera. Many of these tiny cameras, typically surrounded by a ring of LED lights on the end of a flexible stem, are waterproof and dieselproof. They can be inserted into any small tank orifice, pushed down to the base, and moved around to see what is going on. Many plug into smart phones. Remarkably, they can cost as little as $10.

Let's say the tank needs to be cleaned. All kinds of fuel polishing systems are on the market. Although these systems clean fuel by pulling it from a tank, running it through external filters and water separators, and returning it to the tank, they are basically ineffective at breaking up accumulated sediment and slime, and at cleaning biofilms off other surfaces. At the least, a high flow rate is needed to create substantial turbulence, with a suction line at the bottom of the tank to grab the gunk and whatever has broken loose elsewhere and settled. Even this system will still not clean a badly fouled tank, nor can it be used to clean inaccessible baffled chambers. It then becomes necessary to open up the tank to gain adequate access, and this is often a major undertaking. (For more on fuel-polishing systems, see "Polishing the Fuel," PBB No. 112.)

One other approach might be tried before opening up a tank: pump most of the fuel out of the tank, find an opening to insert an air hose, and blast the

In the author's initial attempt to pump down a contaminated fuel tank, a lightweight oil-change pump proved totally inadequate to the task.

remaining fuel all over the tank with compressed air. Pump out this fuel, add clean fuel, and repeat as many times as necessary. Check the tank's cleanliness with a camera borescope.

Gaining Access

The pump-out line, air hose, and borescope will need a modest access hole. Typically, the easiest way is to remove a fuel-level sensor, as most are fitted through a standard 2″ (51mm) hole. Before removing the sender, mark its rim and the tank with an indelible pen so the sender can be returned to exactly the same position and orientation. Carefully pull out the sending unit to avoid damaging the delicate hinged arm and float on the end of it, which registers changes in fuel levels. These mechanisms are not only sensitive but if put back in the wrong orientation, they can also jam on the tank sides or baffles and not work.

Before removing a tank level sensor, first mark the relationship of its rim to the tank so the sensor can be put back the same way around, and then withdraw it carefully, as many are delicate and easily damaged.

It may well be that a larger access hole is needed. I was lucky, as on my boat the various fuel suction and return lines are mounted on a plate that can be pulled out. Otherwise, an access hole will need to be cut in the tank and sealed after the tank is clean. For many tanks, Dutch company Vetus (www.Vetus.com) has simplified this task with its universal inspection port,

The author gains excellent access to his tank by pulling off the plate holding all the fuel suction and return lines, including his fuel tank sampling line.

first brought to the market in 2016. It allows a 6″ (152mm) hole to be cut in the tank and then sealed relatively easily with an opening port for future inspections. However, after going to all this work, the goal must be to keep the tank clean so it never needs to be opened again.

Steve D'Antonio reports that the Seattle, Washington, company Sea-Built has offered stainless steel and aluminum inspection-port kits for many years, which, when properly installed, are leakproof. Note that you must gain access into every baffled chamber to properly clean a tank. See http://stevedmarineconsulting.com/cleaning-diesel-tanks/ for further information and photos of inspection ports, stripper tubes, and a drain well.

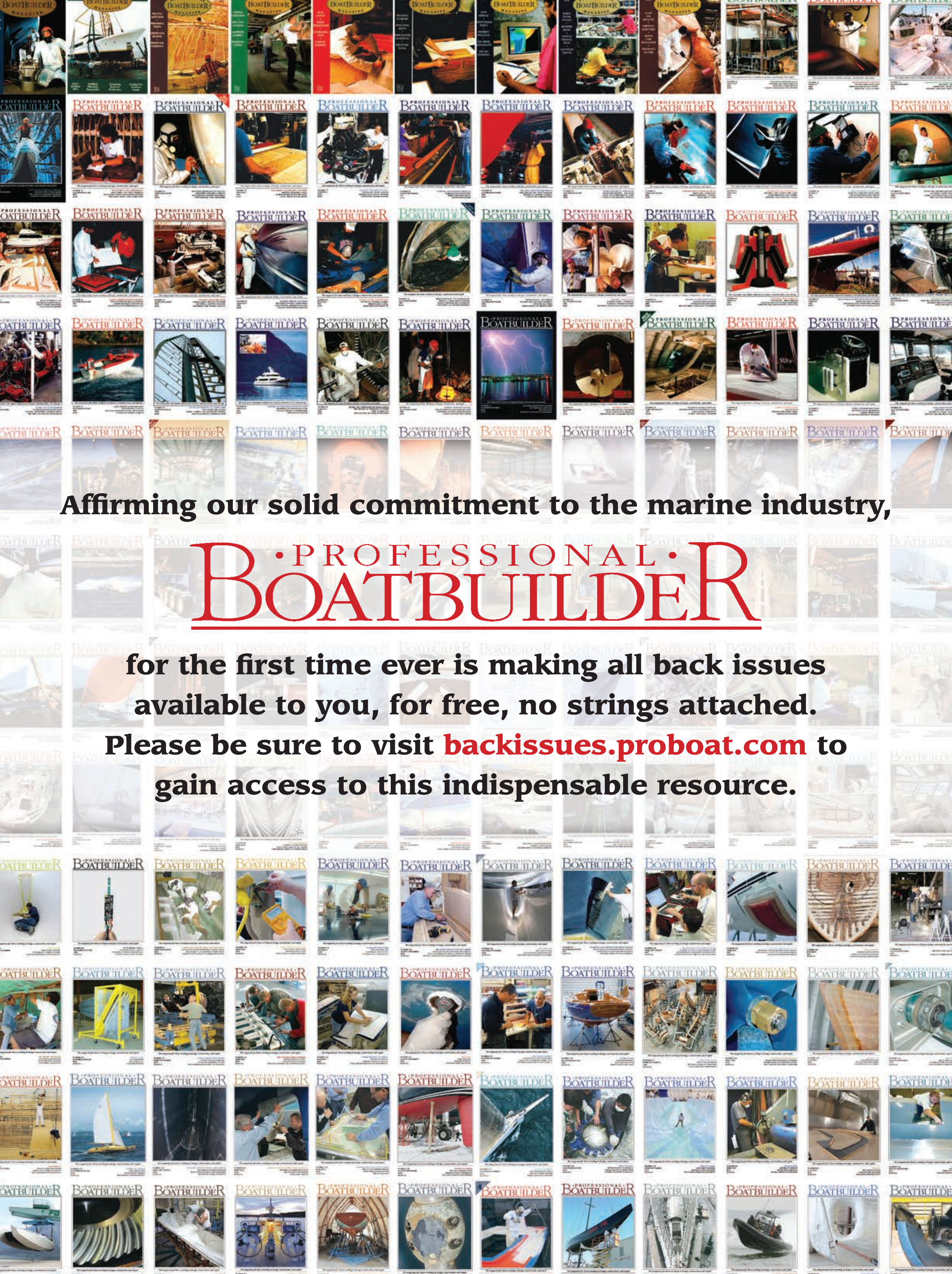
The Art of Obsession

Numerous studies over the years suggest that contaminated fuel almost certainly accounts for most marine diesel engine problems. To head them off, I have always been obsessive about ensuring that only clean fuel gets to my engines, and I'm becoming ever more so. In light of my recent experiences, I have revised my long-standing procedures. I now sample the fuel *before* it goes in the tank. If it is crystal clear, I fill the tank, adding a maintenance dose of Fuel Right at the midpoint in refueling, complete the refueling, let the fuel sit, and, for insurance, sample from the base of the tank. The turbulence during filling may have broken loose some deposits I can now pump out. I sample every couple of months to remove any water from condensates, and I sample before firing up after a boat has been laid up for a season or more.

We have sailed in regions where fuel prices vary dramatically. In the past, if we found cheap fuel, we would fill the main and auxiliary tanks, with the fuel in the auxiliary tank then sometimes sitting for a year or two and occasionally more. I no longer do this. Given the increasing potential for fuel-quality degradation over time due to the addition of biodiesel to fuel supplies, I try to cycle the fuel at least annually. I am contemplating using a stabilizer such as StaBil.

I change my fuel filters at the prescribed intervals, or before a layup (whichever comes first), and expect them to be visually clean. Finally, I have found some relatively cheap and easy-to-use test kits for dissolved water and bacterial contamination, from Dieselcraft (www.Dieselcraft.com). Another company offering bacterial test kits is Conidia (www.conidia.com). The Dieselcraft water kit consists of a powder that turns pink if more than 200 parts per million of water are detected

Left—*With his manual fuel-tank-sampling pump, the author takes samples at the beginning of every boating season, periodically during the season, and at every refueling.* ***Below***—*Before any fuel goes in his tanks, the author takes a small sample to see if it is crystal clear.*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Water and bacteria test kits. ***Top—****Fuel from the secondary filter is tested to see if entrained water is passing through the primary filter's water-separating filter.* ***Left*** *and* ***below—****A fuel sample from the base of the fuel tank is tested for bacterial contamination.*

(this is the upper threshold for dissolved water in various international standards). I use the water test on diesel from the secondary fuel filter when I change it. I want to see if dissolved water is making its way through the water-separating filter element in the primary filter. I use the bacteria test on a sample of fuel drawn from the bottom of the tank, the most likely point for concentrations of bacteria.

My goal is to never again have to haul the diesel off my boat in milk jugs, or to have a yard technician open up the tank to clean it out. PBB

About the Author: *A contributing editor of* Professional BoatBuilder, *Nigel Calder is the author of* Boatowner's Mechanical and Electrical Manual *and other marine titles (including, earlier in his career,* Marine Diesel Engines*), and is a member of the American Boat & Yacht Council's Electrical Project Committee.*

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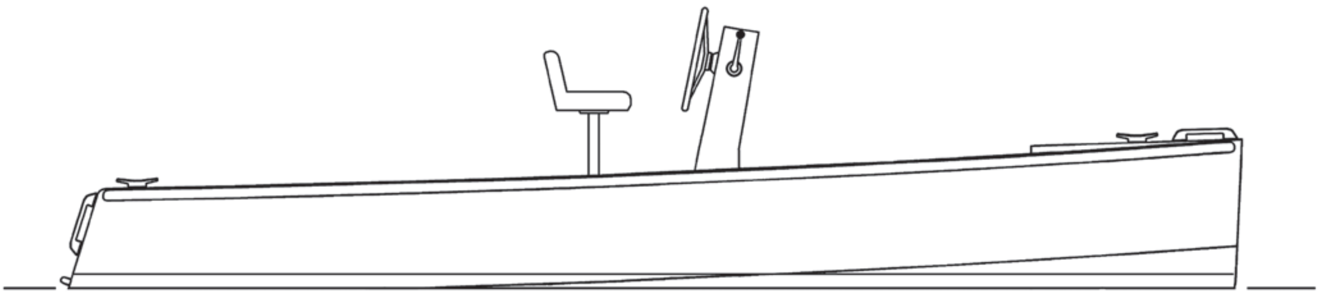
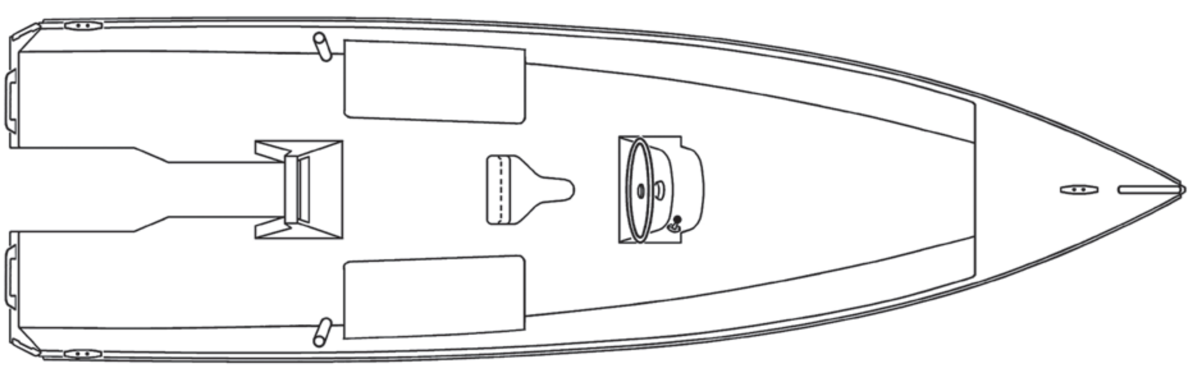
DESIGN BRIEF

DIVE TENDER 14

A new generation of one-person fishing skiffs inspire a slightly larger dive tender and fishing boat designed for easy, affordable access to the water.





Text and graphics by Reuel B. Parker
(except where noted)

Above—The author made his 14' (4.3m) plywood/epoxy outboard skiff lightweight and efficiently driven, with an open transom and an outboard mount about 4' (1.2m) forward to enable easy ingress to and egress from the water for swimming and diving. He designed the boat as a tender for his larger motorsailer when cruising in the Bahamas.

During my last few trips up and down the Intracoastal Waterway, I became aware of a new-to-me personal watercraft. These are small boats that appear to be a type of sit-on-top kayak intended primarily for recreational fishing. Some are human-powered while others have small outboards. The distinctive feature of the latter is that the motors are not conventionally transom mounted but farther forward. The human-powered fishing kayaks appear to be propelled by a pedal mechanism.

To satisfy my curiosity about these boats, an Internet search yielded several interesting examples of small kayak types and one similar but larger craft. Of the former, the most popular is called a Solo Skiff. These boats are marketed as power kayaks dedicated to fishing. Their motor installation is unique in my experience, as it places the outboard on a bracket at the front end of a slot cut right through the well deck and bottom of the boat and extending forward about 3′ (0.9m) from the kayak's open stern. The slot is long and wide enough to allow the outboard's propeller and lower unit to be tilted up and out of the water.

COURTESY SOLO SKIFF

COURTESY SILENNIS

Inspiration for the boat came from the simplicity of fishing kayaks he'd seen on the Intracoastal Waterway ***(top),*** *the popular rotomolded Solo Skiff also built for solitary fishing in the shallows but with outboard power* ***(center),*** *and an open-transom electric-powered skiff from the Spanish boat company Silennis* ***(bottom).***

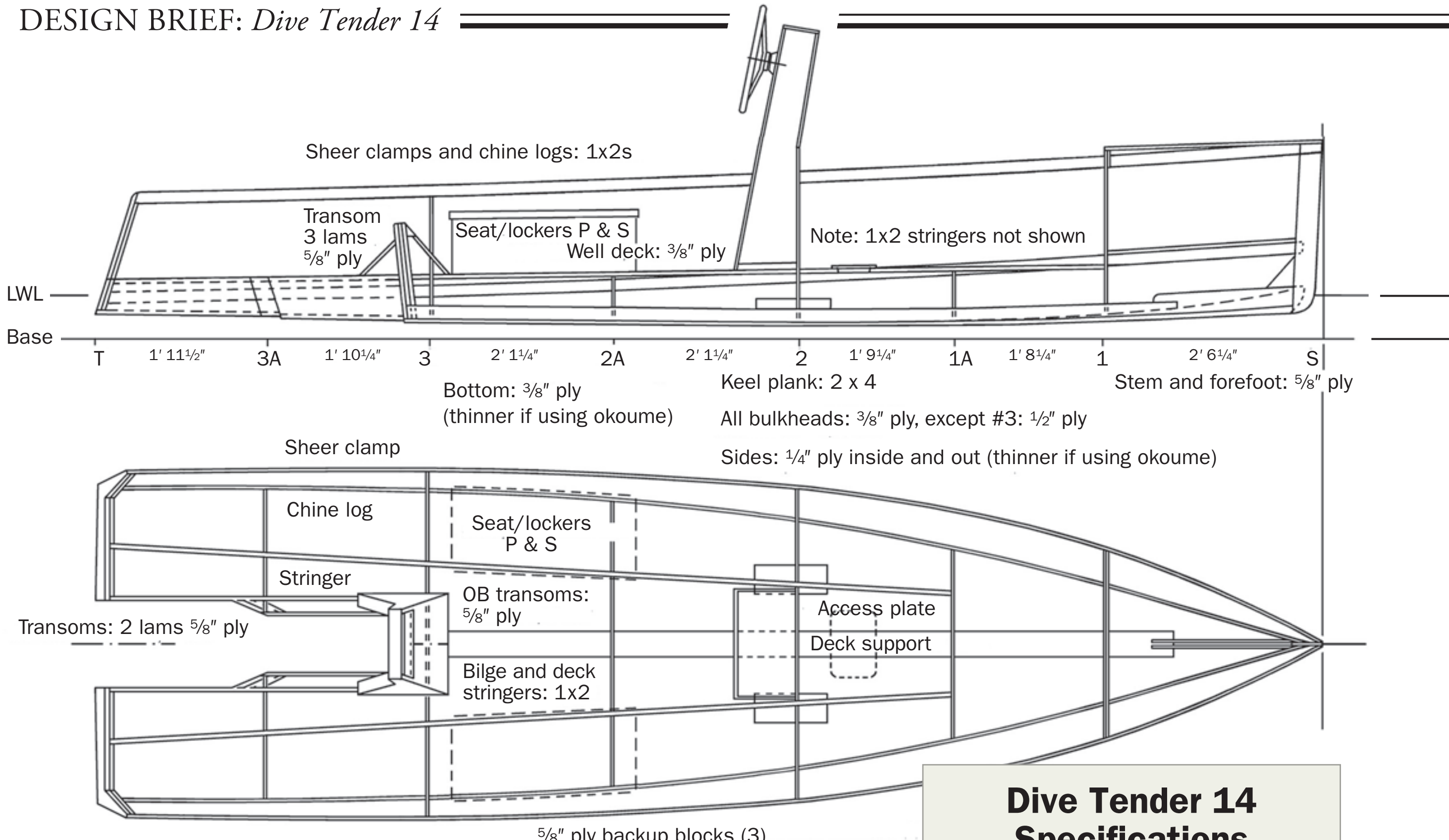
The larger model that grabbed my attention was the Silennis, a new breed of electric boat that also lacks a conventional transom. They are marketed as high-end (read expensive) multipurpose tenders or recreational skiffs. These appear unique in shape, style, and propulsion, and they can be fitted with large battery banks. With four absorbed glass mat (AGM) batteries (12V, 105 Ah), the builder rates the energy autonomy at 9 hours, assuming a cruising speed of 3.8 knots. Options include more powerful lithium batteries, 1.8-kW or 3.5-kW motors, and a detachable transom.

While I applaud the silence of electric propulsion, I am aware that the energy source employed to charge the batteries may be less efficient, overall, than simply installing the most practical fossil-fuel-powered motor available. Those who have been following Nigel Calder's articles in this magazine will be familiar with the issues of electric and hybrid propulsion systems. On such small boats, other considerations include the weight and cost of electric propulsion compared to a conventional outboard or inboard.

My real interest in the Silennis is her hull shape. Viewed from above, the vessel resembles an arrowhead with a fairly broad, open stern and a self-draining well deck similar to the Solo Skiff's but without the outboard bracket and slot. Both vessel types have positive flotation and a sloping aft deck that discharges water through an open stern.

I started researching these boats because I am building my seventh cruising sailboat, and I have been thinking a lot about the tenders I will need. One will certainly be a cold-molded lapstrake Sea Bright skiff, for rowing and sailing, but which is totally unsuited for mechanical power. Because there are times when one really wants or needs to get someplace in an effortless hurry, a second tender *will* have mechanical power, but it will not be an inflatable, which I despise. Nothing does this better than a planing skiff with a V-bottom shape forward for punching into chop.

Important to me are the twin considerations of scuba diving and swimming/snorkeling, which are awkward from most tenders. So why not design a boat to facilitate safe and easy access to and from the water? I think an efficient hull with a self-draining well deck and an open stern would be a boon to divers and swimmers.



Dive Tender 14 Specifications

LOA	14′ (4.3m)
Beam	4′ (1.2m)
Draft	4″ (102mm)
Weight	250 lbs (113.4 kg) dry
Power	9.9-hp 4-stroke 15″-shaft (381mm) outboard
Displacement	275 lbs (124.7 kg)
Flotation	550 lbs/249.5 kg (to submerge deck)
Carrying capacity	475 lbs (215.5 kg)

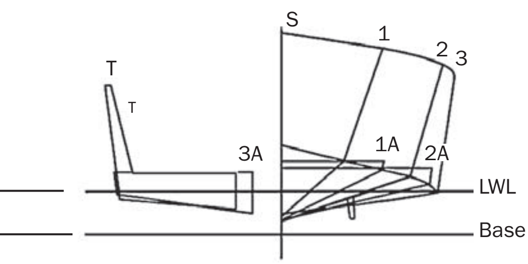
With these elements in mind, and the exemplar boats represented above, I proceeded to design my Dive Tender 14. With her inset outboard, arrowhead shape, deep-V bow sections, and open stern, you can sit on the aft deck to strap on swim fins and diving mask, and just slip into the water. To reboard, you grab one of several handles and slide right back up onto the well deck, less than 4″ (102mm) above the water and dipping even lower with your weight. This is easier than popping up onto the ledge of a swimming pool.

Another common consideration for a tender should be its usefulness for fishing. Once the mother ship is anchored, a skiff gets you to the fishing grounds, and can easily move to a better spot. The Dive Tender 14, with motor up, draws just 4″, making it an effective flats boat that can be poled in ankle-deep water, functioning as a casting platform for bonefish, tarpon, and mangrove snapper. For fishing channels and reefs, you can drift-fish or use a grapple. You will be able to land your fish right on the well deck scant inches from the water. With the elongated outboard motor slot running forward in the boat, a bailing bucket is all you need to rinse the well deck without leaning over the stern to get water. You can clean your catch right there and blood and guts will easily wash back out.

For use as a tender to a cruising boat, the Dive Tender 14 will need to be light and compact. While too large for the average cruising sailboat, she will be best suited to midsize and larger powerboats. For my own 53′ (16.2m) cruising motorsailer, she will be carried in side davits, which have inexplicably fallen out of favor with the yachting world. Because weight is always a consideration, I designed the Dive Tender 14 to be as light as possible, built of marine plywood and epoxy.

The boat is of monocoque construction, and is composed of a single sealed airtight shell. A complication of the open stern is that exceeding maximum carrying capacity will submerge the well deck, sending water forward over the cockpit sole. The sealed boat won't fill and sink, but the effect would not be desirable for passengers and gear. While working on the design, I continually crunched numbers, changing dimensions and flotation volumes accordingly, until I achieved what I felt was the best set of compromises. I considered adding small port and starboard fins to reduce wind drift at low speed, to assist in turning, and to allow the hull to stand upright when beached, but concluded that these are unnecessary except as an option.

Originally, I designed the Dive Tender 14 so the helmsman can drive while sitting on a seat locker, similar to the Solo skiff, but I personally prefer a center-console arrangement. I "borrowed" the basic form of the lovely compact helm station on the Silennis boat, designing my own version. For a

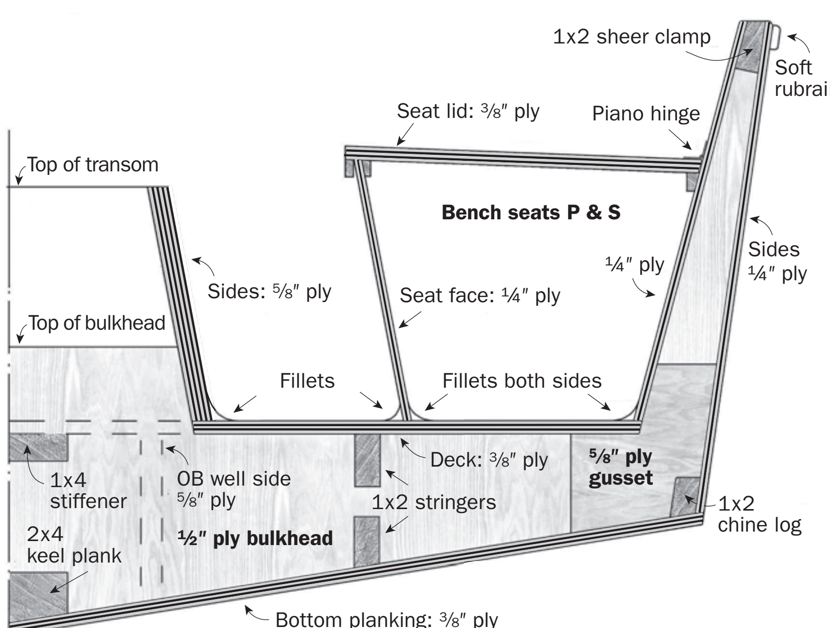


helm seat I designed an enlarged, cushioned bicycle saddle with back support. This will provide a secure seat for tight cornering at speed and for punching into head seas. A built-in or carry-on cooler may be placed in front of the helm station, providing an additional passenger seat, although four people aboard will likely exceed carrying capacity.

I computed weights for all materials, including wood (mostly Douglas-fir marine plywood), epoxy, Xynole-polyester fabric, paint, and hardware. I came up with a dry weight of 250 lbs (113.4 kg), which may be reduced by using lighter-weight, thinner plywood such as okoume. A 9.9-hp 4-stroke outboard weighs about 90 lbs (40.8 kg) dry weight, bringing total boat weight to 350 lbs (158.8 kg) or a little more, depending on how much fuel is carried.

To minimize weight, I specified pine for solid wood components—chine logs, sheer clamps, deck and hull stringers, and cleats—mostly made from 1x2 nominal stock. Small fillets joining hull-to-deck joints will be made from epoxy, expanded silica, and microballoons. For flotation, the hull and deck must form a hollow, airtight structure that can safely become partially submerged when exceeding carrying capacity.

I drafted full-size construction sections for every design station, obviating the necessity for offsets or lofting. Full plans will include these drawings (15 pages total), which are traced directly onto plywood bulkheads with a pattern wheel. **Below** is the construction section for design station/bulkhead #3. Fasteners will primarily consist of pneumatically driven ¼″ crown staples. Bulkhead #3 will be made from ½″ plywood to strengthen the outboard-motor bracket. All other bulkheads will be ⅜″ plywood.



A cross section at bulkhead #3 reveals the structure of the hull in way of the narrow, partial, high transom, which serves as the outboard mount, well forward of the broad, low, open transom at the stern. Plywood is marine-grade Douglas-fir, and solid-wood components are pine. The entire boat is sheathed in epoxy and Xynole fabric.

My specified scantlings for Douglas-fir marine plywood construction are intended for heavy-duty service. For a tender to my motorsailer, I may reduce scantling sizes, employ a lighter, thinner, stronger plywood (like okoume or meranti), and minimize fabric/epoxy covering, which adds substantial weight.

After cutting out the design stations/bulkheads, they are set up on a simple strongback made from three sawhorses with 2x4 girders and 1x2 stanchions. Longitudinal components made from 2x4, 1x4, and 1x2 stock are sprung into place over notches in the bulkheads. Plywood skins are epoxy-glued and stapled over the frame. Basic construction should take about 40 hours; finishing time will depend on the degree of perfection desired. A watertight inspection plate will be located over the deepest part of the hull, forward of the helm pedestal. Steering and control cables will run down through the pedestal, exit to starboard close above the deck, lead into the starboard seat locker, thus exiting to reach the outboard motor. Running the cables below deck might be more elegant but would compromise the boat's essential watertight integrity.

To beach the Dive Tender 14, I designed a simple roller assembly, which can be inserted into the outboard motor slot from the stern. With two people grabbing the bow handles, the boat may be easily brought up onto the beach.

I hope to build the prototype in the winter of 2017–18 and will perform initial sea trials in South Florida's Indian River. The real trials will have to wait until I make my next extended cruise in the Bahamas. PBB

***About the Author:** Reuel B. Parker is a yacht designer, shipwright, author, and cruising sailor. Dividing his time between Maine, South Florida, and the Bahamas, he does business as Parker Marine Enterprises, and is a frequent contributor to* Professional BoatBuilder. *You can read his blog at www.woodenboat.com/whiskey-plank.*

YARD PROFILE

Tooling and Techniques from Schooner Creek

Text and photographs by Dan Spurr
(except where noted)

Steve Rander is something of a legend on the West Coast. For nearly four decades he has built numerous successful racing and cruising yachts, like the 70′ (21.3m) *Rage*, which won her class in the 1993 Transpac, the 42′ (12.8m) *Magic Carpet*, and the 60′ (18.3m) *Ocean Planet* for the Vendée Globe, an around-the-world race. All are cold-molded in wood veneer and epoxy, some over foam core to reduce weight. And he'd earned a reputation as a contender on many of the West Coast long-distance races, like the Transpac, Pacific Cup, Oregon Offshore, and Swiftsure. All this out of a small shop in Portland, Oregon, a hundred miles (161 km) up the Columbia River from the bold Pacific and the famed Columbia River bar.

The short version of his career reads like this: Grew up in Southern California, graduated from high school in 1964, went to work for Joe McGlasson at Wayfarer Yacht Corp. building Islander sailboats, got married, "did some sailing," lived on a boat, got fed up with the mass of humanity in greater LA, moved to Oregon, and in 1977

COURTESY STEVE RANDER (BOTH)

Facing page—*At Schooner Creek Boat Works, crew work on the cabintop for the first of two 65' (19.8m) catamarans at left. When it's finished, a second will be infused while the mold is still on the floor. Underneath the hardtop is the mold for the bridge deck.* ***Above—***Magic Carpet *is a 42' (12.8m) racing yacht built in 1980 in epoxied wood veneer over wood frames.* ***Right—****The 70' (21.3m)* Rage*, also built with wood veneers, has had a successful offshore racing career, including first in class in the 1993 Transpac.* ***Below—****Steve Rander, left, founded Schooner Creek in 1977 and sold it to Kevin Flanigan, one of his customers, in 2015, though Rander is still deeply involved.*

A 40-year-old Oregon custom boat shop relies on ingenuity, thrift, and diversity to stay profitable.

founded Schooner Creek Boat Works. Then, in 2015, he sold the business. Long on my short list of builders to visit, I figured I'd missed my chance to meet Rander. But I wanted to see the Schooner Creek operation anyway, so I contacted new owner Kevin Flanigan and set a date in August 2017.

The current shop, in its third location since the company's inception, is set on the Columbia River, on Hayden Island, looking across at Vancouver, Washington. On entering the office complex, I was greeted by a man of average size, balding, with a boatbuilder's hands.

"Kevin Flanigan, I presume?"

"No. Steve Rander."

"Wow! You're still here?"

"Sshh. I never left."

Flabbergasted but pleased, I followed Rander to his office, where he endeavored to explain his presence. "A couple of years ago my wife and I started to think about retirement. Kevin, the landlord, got into the conversation and bought the company. Now I get to do what I like without worrying about the running of the company." He says this with a twinkle in his eye, as if he's outwitted the fates…or at least the salesmen and creditors he no longer has to deal with.

What he likes to do is build boats, and under the new arrangement, that's what he focuses on. On his desk are plans for a 65′ (19.8m) Morrelli & Melvin (see "Diversifying the Portfolio," *Professional BoatBuilder* No. 127) catamaran, somewhat unusual in that it will function as a day charter in California and as a private yacht.

Kevin Flanigan joined us. "I grew up on a cattle ranch in Colorado," he says. "I saw a lot of windsurfers on a small

lake. Eventually moved to Hood River, Oregon, where I worked in the windsurfing industry for Chinook Sailing Products and Ezzy Sails for about 10 years. At the same time, I was teaching snowboarding on Mt. Hood, where I met Steve and learned about *Rage*, which he was racing to Hawaii. I did a delivery back from Hawaii in 1998 on *Rage*. Since then I had several boats built by Steve at Schooner Creek, including *Hana Mari* in 1999, and *Ocelot*, launched in 2006, which I raced in the Bay Area for eight years as well as here. In 2011, I commissioned a fiberglass and foam Wylie 48 [14.6m] called *Haven*, which is the boat I own now."

Flanigan's transition into yard owner began as a skiing friendship—he's a snowboarder and Rander a telemark skier. The relationship matured when the City of Portland wanted to put a light rail line through Schooner Creek's previous location via eminent domain. Flanigan solved the problem by purchasing the current property. "It has worked out well," he says. "I've been the landlord since '99 and seen all the boats move out of here. My wife, Shauna, and I took over operations in 2015 and have grown the business from 25 to 40 employees. We've got one big boat under way and another about to start, both 65′ Morrelli & Melvin catamarans for commercial use. One for O'Neill Yacht Charters in Santa Cruz for its O'Neill Sea Odyssey on Monterey Bay. The other one we're starting will go to Teralani Sailing Adventures of Lahaina, Hawaii, for the whale-watching and snorkeling market."

Also in the shop is a 28′ x 5′ (8.5m x 1.5m) oceangoing rowboat designed by Eric Sponberg (see Design Brief, PBB No. 161, page 56). The all-carbon craft was commissioned by a U.S. Air Force fighter pilot who, on retirement, wants to row from the West Coast of the U.S. to Australia.

Low-Cost Tooling

Having built 70 boats over 40 years, Rander has learned a thing or two. Despite pleading financial ignorance, he has managed to meet payroll and

COURTESY SCHOONER CREEK

This oceangoing rowboat, commissioned by a U.S. Air Force jet pilot for a planned voyage across the Pacific Ocean, was built by placing foam core over stations. Then, after fairing, carbon fiber cloth was laid over it and wetted out with epoxy resin. Schooner Creek did not make a traditional mold for the boat.

maintain profitability. When asked for insider tips, he first talks about tooling.

"We try to keep the build times and costs down simply to meet the market. One thing Schooner Creek has done well over the years is to inexpensively tool up new projects. We walk a fine line between spending a lot of money building perfect tooling or doing more hand-finishing to create the quality we're looking for."

When I ask how he minimizes costs, Rander replies with a second question: "What is the tool really doing for you? We've built boats and parts on male plugs where all the exterior finish was done on the outside, which is probably the quickest way for a one-off. Much of what we've done over the years has been with veneer or composite foam core so you can do a very quick station/stringer mold and either core or strip-plank or veneer over it to create the hull you're looking for. Then when you're done, just throw away the stations. It's instant. With a multihull, it is actually cheaper to build a one-off female mold with strip planking and do the detailing on the inside instead of fairing the outside of two identical boats. To save time and money, instead of building a plug and then the mold and then the part, we simply

A curved corner section of a seat mold for the catamaran is shown in build.

build a female mold. It's a little tougher getting the surfaces fair, so if you start with a product like wood to build the tooling (it is self-fairing), you end up with a fair product before you have to start working to make it fair. It can't be done in this industry with composites. Everything has to be made fair."

"Doing so many multihulls," I ask, "did you make a female mold for the new M&M catamarans?"

"Yes, we have a cedar-strip-plank mold out here we're producing boats out of. As long as it's protected inside it'll keep right on producing boats."

I mentioned a prominent East Coast custom builder who commissioned a 5-axis-milled plug from a West Coast business and had it trucked across the country, claiming it was less expensive than making the plug itself.

Rander says such builders usually end up throwing the foam plug away, and that his method costs a fraction of "going to a tooling company and saying, 'Tool me up a mold.' All my boats reflect those savings. The trick is to have parts and pieces of tooling you can use for whatever. But for the actual hull shape, you want to build it quick and fair. No sense putting value in it [the hull plug], because there's no value in it for the owner. But it takes a boatbuilder to do it. You can't ask a fiberglass laminator to build it unless he has a tool."

Rander described the process: "The mold is a simple matter of taking what is supposed to be the outside of the hull, using the hull lines as designed and hull offsets, or, as was the case with this boat, a set of Mylars were printed of the stations and half-stations directly from the computer." *[Mylar is the brand name for a stable stretched-polyester film made by Dupont/Teijin Film Enterprises; specifically, it is known as BoPET, or biaxially oriented polyethylene terephthalate—Ed.]*

RANDER: OUTSIDE THE BOX

"First thing we do is ask ourselves: What is it we're actually trying to accomplish?

"To that end, everything is a tool—your employees, your suppliers…they are all tools. If you keep them sharp, everything goes easier. When you think about the guys working next to you in the shop, never ask them to do anything you wouldn't do yourself, and once in a while go prove it. And take on the worst part of any job and prove it can be done as quickly as you say it can. How do you build a 70′ [21.3m] yacht from beginning to end in 10 weeks and have it sailing? There's no way to do it unless you believe it can happen. The objective is keeping all your tools sharp.

"If it's a rush project, how do you keep your suppliers supplying you with everything you need? Usually it's telling them you need it a month early. If your supplier has a problem, then you have a problem.

"Be ahead of schedule at the very beginning. You can't make up time at the end; you can only make it up in the beginning.

"Think outside the box and generate low-cost one-off tooling. The cost of the tool should be less than the cost of the part, so you can get the part out the door as quickly as you can. No sense in building very fancy tooling if you're only building one of them. You have to weigh hand-finish time versus boatbuilding time. If it takes less time to hand-finish the part than it does to build a perfect mold, then you should be hand-finishing the part.

"Depending on hull shape, look at various ways to build the mold as quickly as you can. If you're looking strictly at a one-off, the question is: Do you build it inside out or outside in? You might set out temporary stations and frames and a couple of stringers and core it and do the outside laminate. Finish the outside. Then roll it right-side up and laminate the inside and complete the inside as a quick way to do it. That's a common way to do it.

"But if you are going to infuse or vacuum-bag a piece, you can't do it that way, because you can't get it airtight. Then you have to build a mold that is airtight. If you can build a one-off female mold, great. If you can't, then you need to build a one-off male plug and then hand-finish the entire boat. There is so much more handwork to do.

"*Rage* and *Ocean Planet* were finished that way, but they were wood. The nice thing about wood is it's self-fairing. *Rage* has double diagonal veneers with core in between. Others we built for Hong Kong and Seattle customers were with strip plank because the material was more readily available and it was faster. The outer skins were more conventional 0–90° and 45–45° glass or carbon skins. Look at the structure and see what's the fastest and best way to produce it for your customer.

"I feel sad for those who have not been wood boat builders, because there's a whole world of construction techniques and ideas that aren't existent anymore. So when the average Joe goes to look at building a new project, he has to figure how to get tooling made. How does this happen? How does that happen? In our case, we have been there, and sometimes it's just the old-fashion shoot-from-the-hip solution that's best. We have all those arrows in our quiver.

"One of the guys who worked here with us is now high up in a well-known East Coast boatyard. They ran into a problem on a project and one of the guys said, 'WWRD?'

"'What?' came the response.

"'What would Rander do?'

"I always think: What's the end product, and what's the easiest way to get there?"

—Dan Spurr

Left—*Stations cut in particle board are set up on a strongback.* ***Right***—*Off-the-shelf cedar tongue-and-groove planks are fastened inside the frames to form a female mold in the shape of the hull.*

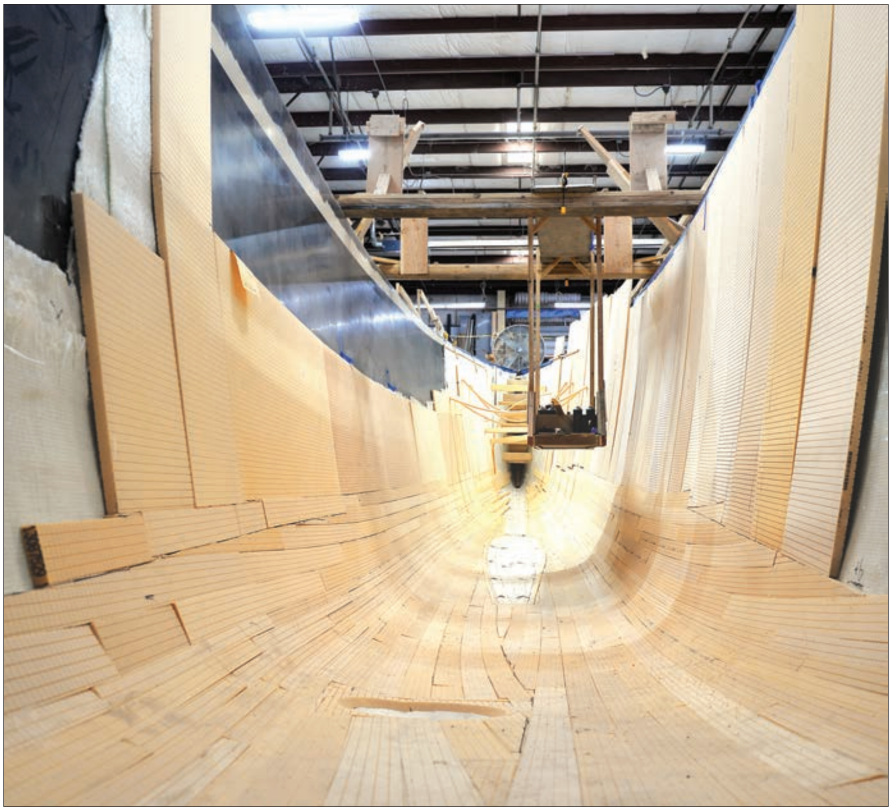
"The normal approach is to build a plug [male copy of the hull] and then build a mold of that. We have been using a shortcut for some time, which is to build just the mold. The lines on the Mylars are enlarged by the thickness of what the skin of the mold will be at the end. In the case at hand [the 65′ catamaran hulls], that was ¾″ [19mm] for the cedar tongue-and-groove and ⅛″ [3.175mm] for the fiberglass inner skin.

"The stations are cut from the Mylars. We had a computer cutter for a while, and it took longer to put the information into the computer for a one-off than it took to cut them on the floor. So we eventually abandoned the computer cutter because we weren't using it, and went back to the old school.

"Once the station lines are redrawn larger and transferred to sheets of particle board, the shapes are cut out using a big router and flexible strips of UHMW [ultra-high-molecular-weight polyethylene] screwed to the particle board as a guide. The stations are stood up on a strongback and braced so they are vertical, centered, and equally spaced.

"At this point, for this catamaran mold, we secured the cedar tongue-and-groove to the inside using glue and screws. With all the cedar in place, the inner surface was given a fairing sanding and then glassed with several layers of light cloth, and all the edges butted and staggered. Once again, a fairing sanding and then Duratec was sprayed on, sanded, and buffed for the mold surface.

"The outside of the mold was coated with WEST System epoxy to help keep



A look inside one of the amas for the second 65' catamaran shows pieces of Divinycell foam core fitted in place. Densities vary according to location.

it from changing shape due to changes in the weather. These types of molds are throwaways and intended for short runs and must be kept indoors until no longer needed. Some carbon fiber was added at the open end of the mold to give it some added strength.

"Once the mold is complete, it is prepared as any other mold would be, using wax or mold release prior to use."

Schooner Creek has taken two hulls out of the mold already, and with two more boats on order, they plan at least six. "And who knows how many more after that," Rander says.

Morrelli & Melvin designed and engineered the hulls to meet American Bureau of Shipping and U.S. Coast Guard requirements. They are cored with Divinycell H80 above the waterline, H100 below, and H250 placed where heavy loads are expected. Coosa board (www.coosacomposites.com) is used for some high-load attachment points such as the transom brackets for life rafts that weigh 800 lbs (362 kg). Skins are E-glass and the laminate is infused with vinylester resin. (Fire-retardant vinylesters are employed for some commercial projects as required.)

Holland Roberts runs the parts department and is charged with just-in-time delivery. "But," Flanigan emphasizes, "we have to inventory certain materials, because lead times are so far out. We never want to run out. On every project, we want to make sure no one ever has to reach for something that isn't there. That only costs you money."

"Going back to the 70-footer *Rage*," Rander adds, "we built it in 10 weeks, and that was simply a case of materials flow. Yes, there were some 20-hour days, but we made sure everything was always there. We sit down with our leads and project what they're going to need. Everything just in time. A lot of materials take a long time to get."

How does all this add up and translate to cost? Flanigan and Rander estimate that they can tool a 65′ cat for roughly half the cost a dedicated tooling business would charge to mill a foam plug. And that, Rander points out, would still just be a rough plug from which the builder would need to make a mold. "Ours was ready to build," says Rander. "From the time we took the order, in two months we were building the boat. That just doesn't happen [making conventional plugs and molds]. Our tooling costs are 50/50 materials/labor, and vary no more than 10% one way or the other."

Most projects nowadays at Schooner Creek are built in composites. The 28′ Sponberg-designed rowboat is all carbon instead of glass, to save, as Rander observed, "the weight of a couple of people riding along for nothing."

But for the big sailboat projects, the

switch from wood/epoxy to all composites has been caused by consumer demand. "Steve was known for wood veneers over foam and epoxy," says Flanigan. "He did that with *Rage*, *Ocean Planet*, and my *Hana Mari*. Unfortunately, people aren't ordering boats like that anymore. And it's harder to get the wood products."

Rander: "The economics have changed, too. At the time, we were buying ⅛″ [3.175mm] cedar-veneer flitches for 38 cents a foot. Now it's pushing $2 or better a square foot. It's more and more cost prohibitive to do wood-veneer boats. We used to have the Dean Co. here in town that was the major producer. They got bought by an East Coast company that didn't understand softwood veneers and ran them out of business. The only place now is in Idaho or Canada, and I can't go over and pick the flitches anymore."

Rander is adamant that wood/epoxy remains a viable method of yacht construction, but notes that "no one promotes it. Most of the ones we've built are still going strong. "*Rage* and *Magic Carpet* have raced competitively in long-distance events for years, the latter dating to 1980. Most of *Rage*'s interior structure was ¼″ [6.35mm], "not ½″, not ¾″," Rander notes. "It's ¼″ because there's other reinforcing, whether it's another bulkhead meeting it, or a stringer. The only exceptions are some of the transverse bulkheads, which are carrying serious rigging loads. They have some pretty heavy beefing up. The berths are sailcloth or ¼″ ply. The sole is ¼″ teak-and-holly ply. It's got a foam core and glass on the back of it to make a sandwich. Saving weight is a case of just thinking outside the box and analyzing the loads each time."

For *Rage*, the deck was two layers of ⅛″ ply with a foam core. There are no deckbeams because, Rander explains, "the boat's hogged front to back [reverse sheer] and with plenty of camber port to starboard. It's like putting two cupped hands together. You can't flex it if you can't bend it. Put them the same way and they bend, right? Frans Maas was the first person, I think, who built boats hogged. If you look at *Rage* carefully, there's a definite hog bow to stern."

Use of Space

As every builder knows, it's critical to anticipate when and where hulls, decks, and other parts must be moved to accommodate work. Schooner Creek's building is 30,000 sq ft (2,790m^2), including a mezzanine where the wood shop is located, as well as a rigging area, and a 10′ x 35′ (3m x 10.7m) flat stock laminating table for laying up bulkheads, soles, and other panels. The ground floor is divided into space for new construction (presently to be filled with the two 30′ x 65′ (9.1m x 19.8m)

COURTESY SCHOONER CREEK

Left—*The rigging shop occupies part of the mezzanine overlooking the building's main floor.* ***Right***—*Full-size patterns are printed on Mylar and then transferred to the material—in this case, Divinycell for parts of the rowboat. CNC cutting was abandoned, as its programming took too long.*

catamarans, the hull mold, and the 28′ oceangoing rowboat), a 35′x 70′(10.7m x 21.3m) paint area, two 35′ x 70′ mechanical service areas, and 5,000 sq ft (465m²) for offices, metal shop, parts department, and employee lunch room.

During my visit, the rowboat occupied space at one end of the main building hall, and next to it was the big cat under construction, then its cabintop, and then the hull in mold. When finished, the cabintop will be raised

The nearly complete 28' (8.5m) ocean-voyaging rowboat, built of carbon fiber and foam, displaces 2,587 lbs (1,172 kg). The boat is designed to carry 500 lbs (227 kg) of supplies and 1,000 lbs (453 kg) of food.

and attached to the deck of the catamaran, so a second cabintop can be started while the mold is still in place. The second cabintop and mold will go into storage until they're ready for them—that is, once the second catamarans' hulls and bridge deck are laid up and connected. Presently under the cabintop mold, the bridge deck mold will go outside to join the cabintop mold in storage after the second bridge deck is laminated. Then the two hulls of the next catamaran will be positioned where the mold was, and the bridge deck dropped in between. "It's like coordinating a dance," Flanigan says.

And what of the hull mold? It's kept indoors safe and dry; the outside space between the stations is used for storage of gear and supplies on temporary shelving.

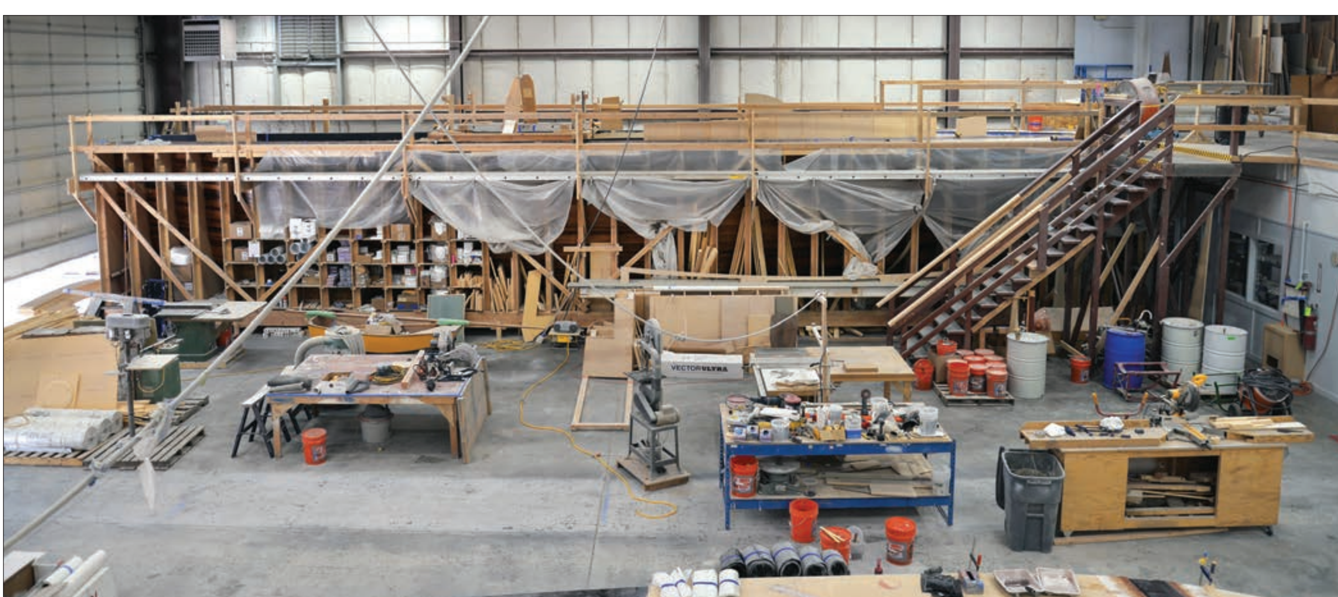
Patterns were made up for all deck sections. "As we move this boat out and the next boat in and start building it," says Rander, "we move the patterns back up to the flat table on the mezzanine. We're always looking for ways of making things easier."

When it's time to move out the first boat, the building is set up so a stub wall and I-beam come out, and the doors roll up for sufficient clearance to move the boat outside on a hydraulic trailer. A 300-ton crane will hold up the roof of the building until the boat clears; then the stub wall and I-beam will be replaced and the crane freed to lift the boat off the trailer and lower it into the water.

Marketing

Most of Schooner Creek's new construction comes from designers, who in the past have included Robert Perry (PBB No. 97), Kurt Hughes, John Marples, Tom Wylie (PBB No. 165), and the late Bill Garden. "It's just a case of somehow getting in contact with the designer and having them aware of what you produce," says Rander. "Designers want to keep their customers happy and have great boats they can show off. So if you, as a builder, can produce those things, you get to be a friend of that designer for a period of time; it's a win-win for all."

Schooner Creek also benefits from its longevity. "We've been here forever," Rander says. "People see one of our boats somewhere and are interested. We also have a good reputation in the Hawaii charter industry. So when someone wants a new boat, we're often the ones they talk to first.



This view from atop the first catamaran looks across the shop floor at the hull mold. Note temporary storage between stations of the mold.

Hughes, M&M, and Wylie have referred a lot of clients."

Flanigan: "New construction and repairwork are largely word of mouth. We advertise locally and support a lot of the yacht clubs in town as well as their racing. We have a strong presence in the Portland marketplace. For repairwork and maintenance we believe there are not a lot of other options. As for new construction, we've got work for more than two years, and Steve is roughing out the next build."

Crew

Pascal Le Guilly, a Frenchman who started at the yard painting bottoms, is now an American citizen and the general manager. "We use many of the same materials as other shops," he says, "but the crew Kevin put together makes a huge difference. Doesn't matter if it's 100° or cold and snowy outside, they show up every day. And they work together as a team. They help each other. They don't let each other down."

"We have very little turnover," Flanigan says, "People enjoy working here. It's a family atmosphere. We have very competitive benefits, including health insurance, PTO, and 401(k)."

Working on the designer's specifications to stiffen the structure, project manager Adam Blankinship wets out carbon fiber reinforcements added to the cabintop before the final layer of fiberglass is applied.

Currently there are about 40 on the crew. Flanigan says he tries to keep the number under 50. The yard runs two full teams, one for service and one for construction. "It's challenging to make that balance," he says. "You don't want to stop service to go on to build or stop build to go on to service. You've got to protect both industries as their own entities. And that's why you get so good at both."

As with so many yards across the country, finding qualified, capable employees requires constant effort. "We're bringing in people from all over the country," Flanigan says. "From Port Townsend to Miami, we have to spread a pretty broad net to get people. But we're lucky, as there's a lot of composites happening here. We try to lure them away from aerospace."

Once hired, crew are trained in-house and via a variety of training programs, including those developed by the American Boat & Yacht Council (ABYC), and organizations such as Wing Inflatables in California and Boatswain's Locker training for servicing Steyr Motors. For developing infusion expertise, Schooner Creek brings in a trainer from DIAB (www.diabgroup.com).

Repairwork remains Schooner Creek's bread and butter. Its location on the Columbia River has a 6' (1.8m) tide, 100 miles (161 km) from the ocean.

Service and Repair

The yard totals more than six acres (2.4 hectares) of which two are dedicated to long-term storage for customers' boats; and the remaining four, less the footprint of the building, are made up of a mast yard for rigging, haul-out area, and a repair/service area. There are another two+ acres of water with docks and two floating work sheds.

"The majority of our business is repair," says Flanigan, who saw the wisdom in developing a predictable revenue stream. Two lifts, 25- and 70-ton capacities,

The company invested in a StormwaterRx water-filtration system for the outside yard.

are the largest on the river and enable the yard to handle boats up to 70′ (21.3m). The ways and docks were added after Flanigan bought the property.

In the environmentally sensitive political climate of Oregon, it also made sense to comply with and/or exceed Environmental Protection Agency and Occupational Safety and Health Administration regulations. (“We’ve had OSHA in here,” Rander says, “with our guys wearing badges” to measure exposures to VOCs.) A storm-water-recovery system filters all the water. “The rainwater leaving this property is tested annually to meet DEQ regulations,” says Flanigan, noting that they encourage enforcement of permits and regulations, and that he made the decision not to operate a marina on the premises—all boats at the docks are here for work.

They don’t build metal boats, but repair steel and aluminum. There is a metal shop in the main building with welders on staff. Routine work is performed on engines, fiberglass, wood, paint, and rigging. Canvaswork is

Above—*Work orders and boat keys are neatly set up in the office.* ***Right—****A crew member buffs a hull in the paint booth adjacent to the main building hall.*

outsourced. Schooner Creek also represents Steyr Motors and Doyle Sails.

The yard has developed a strong relationship with the Portland Coast Guard personnel who conduct new-build inspections. "We do our work well enough," Rander says, that they "bring their aspiring inspectors here to learn. Whenever we have an infusion going on we invite them to come by. We'll explain why we're doing it and how we're doing it. It's a great way to go: Keep everything on top of the desk, nothing underneath it."

Portland is an active commercial port. Container ships come in from the Pacific Ocean, and towboats come down the river from Lewiston, Idaho, carrying forest products and grain. "We don't generally get involved," says Flanigan, "but we do with some of the high-speed boats and lifeboats that come off the ships, which need annual service, paint, and gelcoat repair. That's been a good source of business for us. We've become pretty diversified."

"We do new construction to advertise to the repair customer that if we can build *new* boats, we can certainly repair *their* boats."

—Steve Rander

Rander says he read once that one should never have a repair yard build you a custom boat, because they are inefficient. "I laugh," he says, "because I think we are the other way around. We do new construction to advertise to the repair customer that if we can build *new* boats, we can certainly repair *their* boats." The repair business is Schooner Creek's bread and butter, its mainstay, because it's ongoing all the time, whereas new construction is subject to what Rander calls "the whims of the economy and the customer."

"So if it's risky, why do new construction at all?" I ask.

"Because it's fun!" Rander replies quickly. "It's good money when it's all working and the economy is going and everybody is buying boats like is happening now. In 2008 it sucked. We had some big projects that got us through to 2010, but thank god we had the repair business."

Schooner Creek has indeed proven itself a smart shop. And compared to a lot of marine businesses, it is no longer a small shop. PBB

About the Author: *Dan Spurr is an editor-at-large of* Professional BoatBuilder.

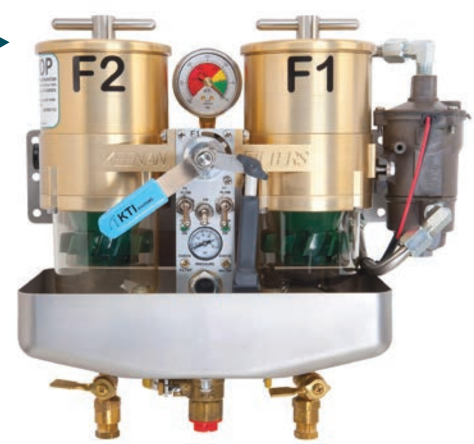
New Products and Processes

Professional BoatBuilder's advertising department uses this section of the magazine to publish excerpts from press releases showcasing the newest products and processes in the marine industry. For a more complete selection of press releases dedicated to new products and processes, please visit **proboat.com**.

FUEL FILTRATION SYSTEM

KTI Systems Inc. (Southwick, MA) introduces a new fuel filtration system combining all the tools necessary to ensure clean, uncontaminated fuel delivery. Features of the system include fuel polishing, filter switching, servicing, clogged filter and water detection warnings, a back-up fuel pump, and integrated communication. A separate warning and operation panel can be placed in the cockpit or navigation station for remote monitoring and alarm control, and there is an option to add a smart phone interface allowing the operator to monitor the filter warning system and schedule fuel polishing from a mobile device. Three basic models are available in 60 or 120 gallons per hour flow rates.

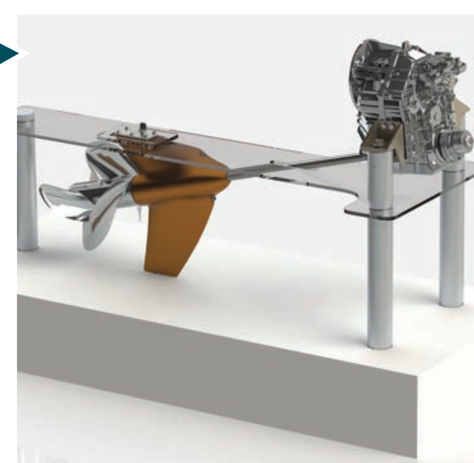
Contact: Andy Keenan, 413-569-3323; www.keenanfilters.com



PROJECT DISRUPTION CONCEPT

ZF Marine (Friedrichshafen, Germany) and Special Driveline Technology introduced a new propulsion concept at the 2017 Fort Lauderdale International Boat Show. The Project Disruption concept allows shaftline boat builders to harness the benefits of contra-rotating propellers, including increased efficiency, acceleration, and reverse authority. The concept is comprised of a strut-housed underwater gearbox which transmits power to two-contra rotating propellers and offers improved reversing performance and low speed maneuvering by eliminating the propeller torque that currently affects single shaftline applications. The concept is sized for tow sports boats, but can be scaled to larger propulsion packages or hybrid systems.

Contact: Martin Meissner; 954-441-4052; martin.meissner@zf.com; www.zf.com



TACO MARINE HELM CHAIRS

Taco Marine (Miami, FL) manufactures a variety of high quality, luxury helm chairs. The Capri helm chair comes in three models: the Standard chair comes with or without armrests and has a fixed bottom seat, the Capri Deluxe chair includes adjustable armrests and a 25″ or 28″ bolster seat, and the Capri Deluxe bench chair includes adjustable armrests and a 36″ or 40″ bolster seat. The Captiva helm chair features an ergonomic design for comfort on long trips and has pleated inserts, folding armrests, and a hinged bolster pad. The Coastal helm chair comes in a standard or deluxe model, and is ideal for boats up to 30′. All TACO marine helm chairs are made in the USA and come with a three-year warranty guarantee.

Contact: TACO Marine; 800-653-8568; www.tacomarine.com

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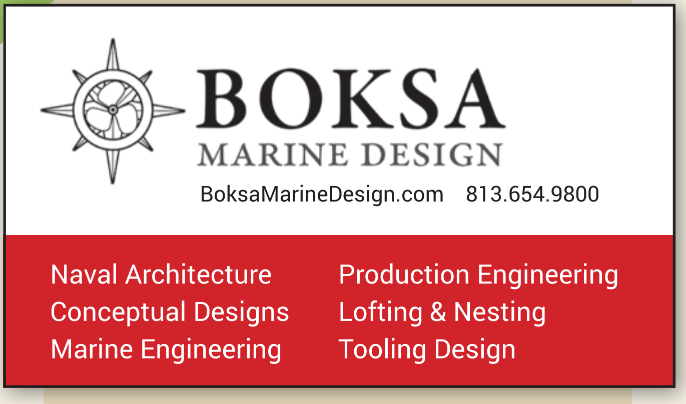

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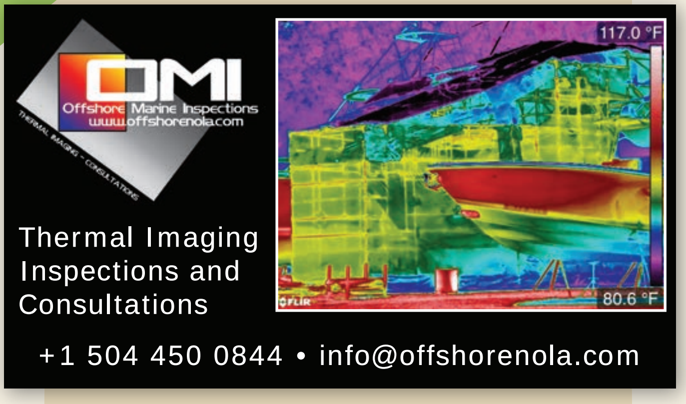

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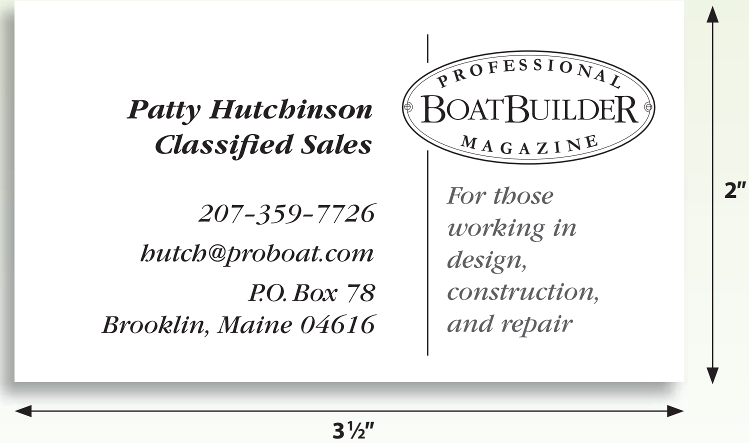

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What's Certain About Training Is You

by Leon MacCorkle

At some point in everyone's career they stand back and think about where they came from and where they are going. The looking-forward part most often includes training or education to advance in the current job or to learn skills for a different career path. Education and job certifications are as unique as every individual, and are often transferable from one trade to another. When I look back at my own working life, I am amazed at how the training and certifications from my earlier careers set me up to be successful in the job I have now. Who knew that as a professional firefighter I would learn skills I now use in a boatyard? I had no idea along the way that I would be where I am now, so I can't take much credit for making conscious, deliberate decisions. Upon reflection, it's clear that what got me here was eagerness to learn everything I could and an interest in trying new things. The rest was fate.

As a custom boatbuilder and boatyard owner I wear many hats, the most important of which is keeping myself and my employees trained and up to date on changes in our industry. Many of the crew we hire have some certifications, but most often we select people who have a real interest in boating and an aptitude for learning. In our corner of Maine, experienced employees are hard to come by, so in-house on-the-job training is the norm. But this approach can take an employee only so far. At some point, someone growing in the profession will need advanced training from outside our yard.

Like most of the nation, Maine has no effective formal marine-trades-apprenticeship program, though I appreciate various efforts under way to create one. While we have some really great schools for boatbuilding and marine trades in our area, it's not practical to take employees out of the workplace for the long stretches of time their programs demand. So our default for training is the American Boat & Yacht Council (ABYC). I disagree with some criticism the organization has had recently in these pages (see the Parting Shot "Uncertain About Certification," in *Professional BoatBuilder* No. 170). I see ABYC as essential baseline training for both the standards we use in boat building and repair and the minimum education my employees need to be successful in their careers. The cost is affordable, and the time away to train and test is manageable. It is the *only* option we have at the moment, and it works very well for my crew. From my perspective, when I hire people with ABYC certifications, I know they have the basics down, and for the rest of their skills I'll look elsewhere in their résumés.

Here's a message for prospective employees: Don't be put off if you don't have experience. Most people in this industry fall into it because they love boats. Their backgrounds and formal education often have little to do with the jobs they hold. You don't need to be certified or have schooling to get hired, though it certainly helps. Most of the boatbuilders and yard crew I know are valuable because their skills are not highly specialized. They are well rounded and can do more than one thing, be it woodwork, fiberglass, wiring, onboard systems, or sometimes just being organized. If you think you want a career in boats, then get started. Gain experience. Then, once you have mastered your position in your company, get some training outside and better yourself. Read this magazine, and take an ABYC course that interests you. One great thing about knowledge is that no one can take it away from you. You take it with you through life as well as from job to job. Enjoy your career and learn what you can every day.

When the time comes that you are dissatisfied with the training available to you, look to improve it. Become the teacher. Pass your experience and wisdom on to those around you and the generations moving up. There is a whole side career in teaching. Think of Steve D'Antonio, Nigel Calder, and Roger Hellyar-Brook—the guys moving our industry forward by teaching. Give back to the industry that has supported you. It is easy to point a finger at ABYC or a trade school and say they are not up to par. It is another thing to step up and be the teacher, but the fact is everyone needs people with experience to learn from.

We all have the opportunity to grow and learn in our lives and in our careers. Some people actively advance their careers, and some are content with the status quo, but it is nearly impossible to go through life and hold down a job without picking up valuable skills or information that stays with you. The rewarding path is to learn something new every day, and then to share what you know with others. It keeps your mind engaged and gives you more than a couple of reasons to be glad to get up in the morning. PBB

About the Author: *Leon MacCorkle has been in love with all things boating since his first job as a boatbuilder at age 14. His career has come full circle, as he now owns Padebco Custom Boat Builders and Boatyard in Round Pond, Maine.*


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