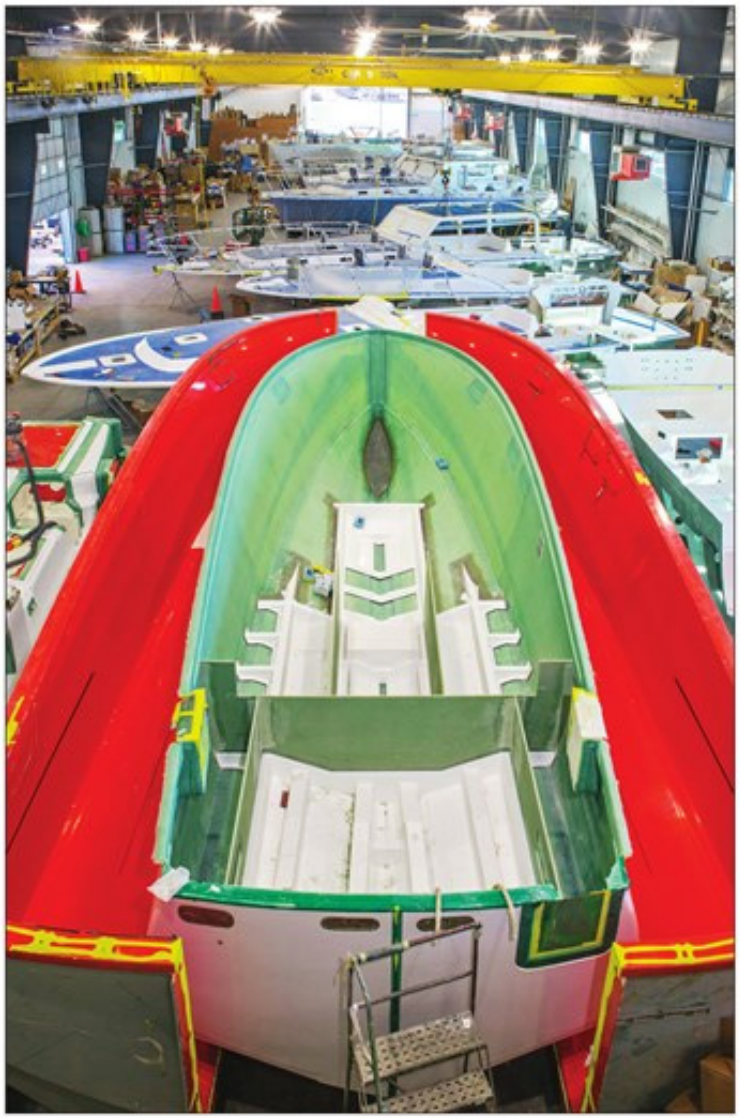
The Builder Under the Bridge

Boston BoatWorks co-owners Mark Lindsay and Scott Smith have been delivering complex, lightweight, fuel-efficient power cruisers in wet-preg epoxy composites for the last dozen years—*production-built* for Bob Johnstone's MJM Yachts.

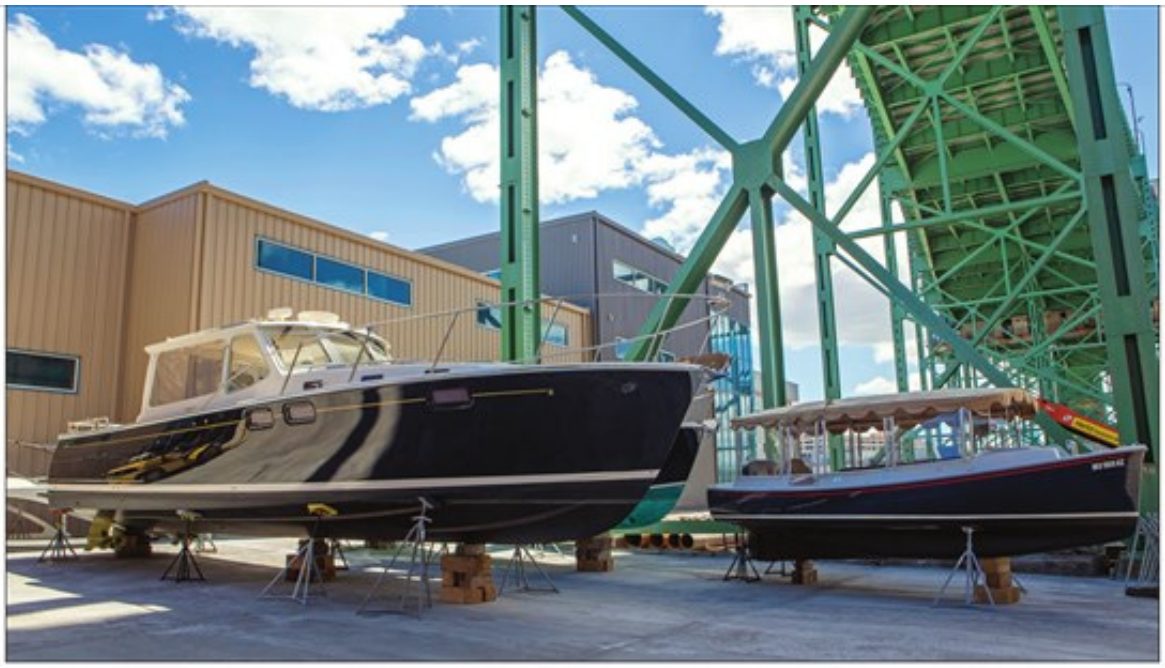


by Paul Lazarus

Photographs by Billy Black (except where noted)

In late February of 2015 Boston was digging out from a record winter; large snowbanks impinged on miles of aging turnpike just north of the city. I exited this roadway after crossing the Mystic River on the Tobin Memorial Bridge, headed for Charlestown. Proceeding past the Navy Yard and the *USS Constitution*'s berth, I followed Scott Smith's directions through the grit of industrial Charlestown, most of it vintage brick buildings, since there was no signage identifying Boston BoatWorks' still-unfinished shop.

I parked my car beside a Marine Travelift with Boston BoatWorks' name on the crossbeam. A tugboat steamed by. Light snow fell from a gray sky. To my right, people wearing hoodies parked factory-fresh imported cars on a waterfront staging area, queuing them for further transit aboard a ferry barge soon to appear. Off to my left, municipal workers in bucket loaders and dump trucks attacked piles of old plowed snow. And literally overhead was the tallest and longest bridge in New England. Tobin's double-deck, three-span, cantilever-truss steel structure, 2 miles (3.2 km) in length, dates to 1950; its lower deck arcs 135′ (41m) above the river. There was no doubt that I had arrived at an increasingly rare phenomenon: an urban industrial

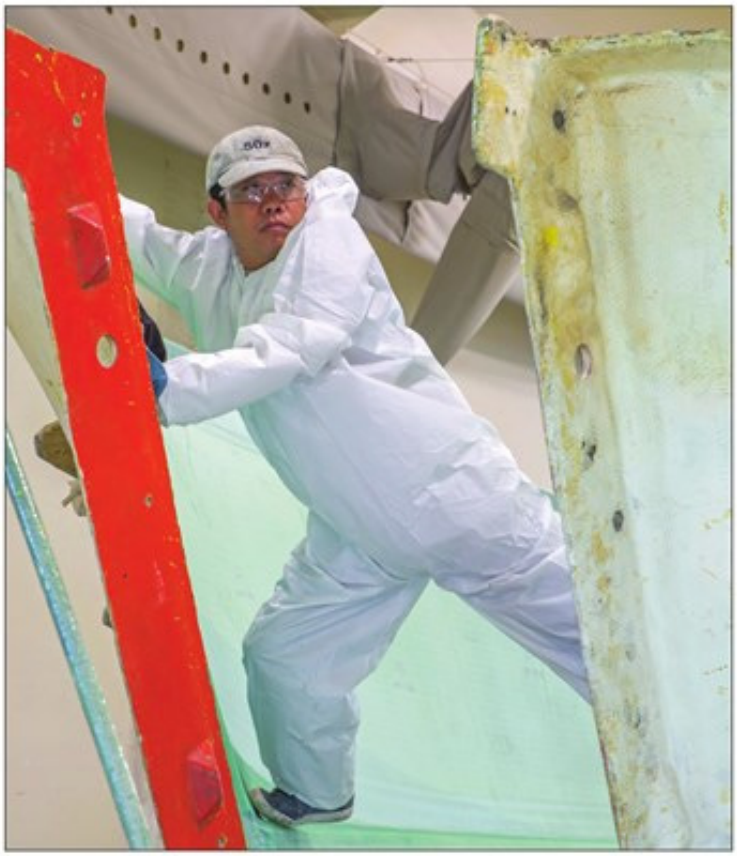


waterfront boatbuilding shop, and this one was new.

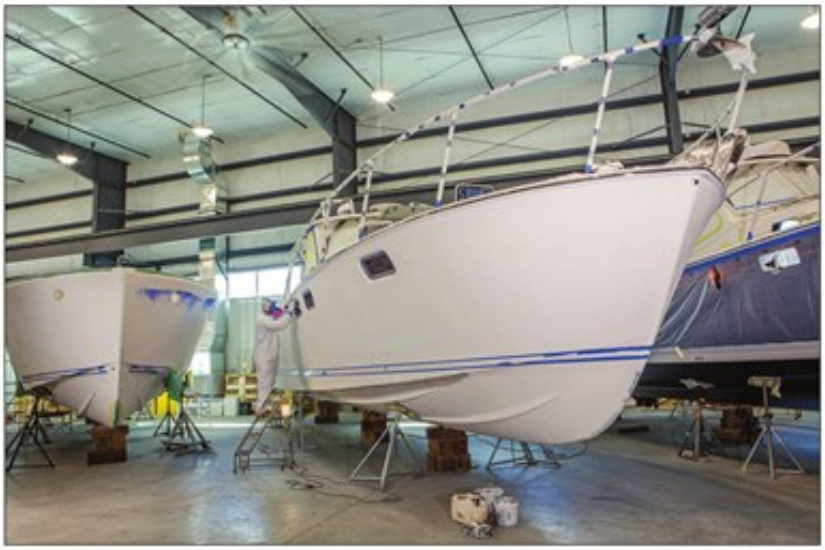
BBW's masonry-and-glass main building, which houses production and assembly on the ground floor with administrative offices above, sits on a strip of land alongside the steel uprights of the looming bridge. Between the plant and the auto staging area, the builder keeps a row of tooling and assorted boats stored under shrink-wrap.

More significant than its site, though, is what BBW has accomplished to date and continues to improve upon. While numerous boatshops here and abroad build sophisticated wet-preg epoxy composite yachts, those are typically one-off projects. Only two shops, in this country at least, can be said to be *in production* using wet-preg epoxy composite construction: Outerlimits Offshore Powerboats (Bristol, Rhode Island), and Boston BoatWorks. Of these two companies, only BBW is turning out product in real volume: ocean-capable performance motoryachts ranging in size from 29′ to 50′ (8.8m to 15.2m).

Professional BoatBuilder's prior visit to BBW, in the spring of 2005,



***Top**—Against the backdrop of Boston BoatWorks' brand-new Mystic River facility, a pair of MJM Yachts, left, and a traditionally styled launch await launching or trucking. Looming overhead is the Tobin Memorial Bridge, the longest span in New England. **Above**—A BBW crew member guides together the split tooling for an MJM 40z (12.2m) in preparation for joining the halves of the foam-cored hull with a thick centerline lamination. For BBW's cored epoxy wet-preg process, in-mold laminators place and tailor precut and pre-impregnated reinforcements. By contrast, in conventional open-molding operations using styrenated resins, hulls and decks are done as manual layups or sprayups. **Facing page**—Having completed its cook cycle, a freshly laminated 40z hull with structural grid installed, is demolded in preparation for final assembly and fitting out on the main production floor.*



Its subcontracted deck-railing system already in place, a 50z (15.2m) in progress gets portlights. By design, BBW's busy production hall is organized like a so-called open classroom: since everyone can see the construction activity occurring throughout this space, it helps cross-train shop-floor personnel and encourages upward mobility among them.

was to the company's original location not far from this one, in East Boston on the same waterway. My visit a decade later was to see the new facility, and meet with Smith and Lindsay to discuss notable changes and upgrades to their operation. But before stepping inside the main building, let's restate some relevant background on the BBW–MJM relationship, and the rationale behind the boats' wet-preg construction.

In the mid-1970s Bob Johnstone, then vice president of marketing for AMF Corporation, a major American conglomerate at the time, was unable to persuade AMF to produce the performance keelboat he and his brother Rod had in mind. So the Johnstone brothers—both of them passionate about sailboat racing—went into business to build their idea themselves, and subsequently developed J Boats into one of the great international success stories in modern production boatbuilding (see "J Is for Johnstone," PBB No. 98).

By the early 2000s Johnstone and his wife Mary, life partners and boat mates, with a shared preference for racing sail, had shifted from sail to power, as have many other cruising and racing sailors of a certain age. The Johnstones owned a Dyer 29 (28.5'/8.7m), an able and versatile fiberglass powerboat in production continuously since the mid-1950s. However, the powerboat the Johnstones *really* wanted, one that met their fairly reasonable requirements, did not exist. So Bob Johnstone once again created a company to build the exact boat he sought.

The wish list? A good-looking boat Mary could handle alone; fuel efficient but a performance vessel able to safely venture offshore; spacious enough for comfortable socializing with guests; and easy to maintain—in roughly that order of importance. Ever the mastermind and certainly no stranger to the recreational marine industry, Johnstone set about identifying and assembling the technical talent necessary to make Mary Johnstone's Motorboat (the origin of the initialism "MJM") a reality. Johnstone, as he told *Professional BoatBuilder*, had no interest in starting another powerboat company for its own sake (see PBB No. 99 for stories, by Dan Spurr and Bruce Pfund, on MJM Yachts and Boston BoatWorks).

The crucial design/build team that Johnstone put together consists of designer Doug Zurn (Marblehead, Massachusetts; he's the "z" following each MJM model number in the product line), and master builder Mark Lindsay.

Johnstone—and brother Rod, whom Bob consulted—held Zurn's design aesthetics in high regard. Johnstone also had every reason to expect reliable performance throughout the speed range, given Zurn's impressive portfolio in power and sail.

As for build, Johnstone knew from the outset that any prototype of a production MJM would have to be made of strong, lightweight composites, precisely the construction medium that Mark Lindsay had been expertly working in for more than 30 years at that point, always evolving with advances in materials technology. Lindsay had built not only a number of winning sailboats, but atypically for a builder, he'd also been a champion sailor in several one-design classes, and the technical manager for a successful *America*'s Cup campaign.

Lindsay and Scott Smith formed Boston BoatWorks a half-dozen years before Johnstone approached them with his MJM Yachts proposal. (BBW

Under the Tobin Bridge supports, Boston BoatWorks co-founder Scott Smith monitors the loading of the 40z mold into the slings of BBW's Marine Travelift, which will carry the tool into the laminating area at the north end of the company's Charlestown, Massachusetts, production plant.

is the sole builder of these boats, whereas J Boats has had more than one licensed manufacturer globally.) Smith brings to BBW a remarkably varied résumé that includes biomedical engineering, financial services (mutual funds), and banking, all in the Boston area. Like Johnstone and Lindsay, Smith too began racing sailboats as a kid; a Lindsay-built competition 40-footer (12.2m) is what initially whet Smith's interest in Lindsay's work.

Besides managing BBW's financial affairs, Smith has been active in Boston-area civic affairs, particularly East Boston's—its Chamber of Commerce, its Economic Development Council, as well as a nonprofit youth sail-training program, which he started and serves as a trustee. It was Smith's sustained participation in the Boston Redevelopment Authority's planning advisory committee for the municipal harbor that fortuitously led to BBW's new location. The BoatWorks qualifies as a bona fide modern marine business on a venerable commercial waterfront where there was none. BBW does not own the property it occupies, but its new production plant and administrative offices were built to Smith and Lindsay's specifications by the property owner. (BBW's earlier shop, in East Boston, was a leased, repurposed facility formerly part of Bethlehem Steel.)

Still another critical player for executing Johnstone's vision of a light-but-strong MJM motoryacht is Steve Burke, a graduate naval architect specializing in structural design, who'd already engineered limited-edition, high-performance models in the J Boat line. Beyond designing the structure for MJM's prototype—a "pocket" motoryacht at 34′ (10.4m), currently discontinued—Burke was charged with securing for later, larger models (at 40′/12.2m and 50′/15.2m) the highest possible standards for small craft, as established by ISO, the International Organization for Standardization. These standards, said Burke, "are the emerging worldwide regulations governing the design and construction of vessels, both power and sail, of up to 24m [79′] in length." It's noteworthy that the MJM 40z is the only *planing* powerboat of its size to achieve ISO's CE mark for "ocean" certification. According to Johnstone, the 40z's structure is built to withstand 21′ (6.4m) ocean waves at speeds over 40 knots. There are no guarantees as to how the people onboard would fare running at speed in such conditions.

Let's get back to Lindsay. His hands-on experience in composite construction complements Burke's engineering expertise. Lindsay's boatbuilding career goes way back, to his teens, spanning several one-design and rule boats, and producing numerous champions—Sailfish, Stars, 505s, Fireballs, Flying Dutchmans, Tornadoes, MORC, IOR, and IMS boats—plus much of the technical work on *America*^{3}, the 1992 winner of the *America*'s Cup. The reason so many of his boats have been so successful is that he is always searching for strong, lightweight structures, and was among the first builders to use—in boats—what were previously thought of as exclusively aerospace materials.

COURTESY MARK LINDSAY

BBW master builder Mark Lindsay works the trapeze of an International 505 racing dinghy as sailcloth manufacturer Bob Bainbridge handles the helm, at the class's East Coast championships off Newport, Rhode Island, in 1979. (Mark and his wife, Sally, won the North American championship the year before.) Lindsay's expertise in advanced composites and construction processes began with high-performance one-design small craft like the 505, a class he considers "the best boat ever."

It is no accident that most of Lindsay's building career has been committed to sail, the bulk of it to very small craft, and the faster the better. His exploration of how to exploit composites to make sail-powered small craft lighter, stronger, faster began at Massachusetts Institute of Technology, where he studied for a graduate degree in architecture and architectural engineering. (Lindsay started college at Middlebury, but dropped out to work as an "apprentice laborer" in a Marblehead boatyard that had been commissioned to build an A-Cup contender, before pursuing an undergraduate degree in architecture from the University of Pennsylvania.)

Taking information gleaned in a structures course at MIT, Lindsay would test samples to failure in the materials lab. Meanwhile, MIT's Sailing Pavilion, a boathouse on the Charles River laying claim as the birthplace of competitive college sailing in this country, served as a test tank for him, racing so-called Tech Dinghies. The design dates to 1935, when MIT naval architecture/marine engineering professor George Owen drew the plans and the Herreshoff Manufacturing Co. produced a fleet of 30. Today's Tech Dinghy, the design's sixth generation, is a carbon fiber raceboat.

For Lindsay, the interaction of his MIT structures studies and sail-racing experience was formative: it taught him, he said, the important difference between *stiffness* and *strength*. Understanding that distinction enabled him, when he turned professional, to give his boats a truly competitive edge by lightening them within a class's

COURTESY MARK LINDSAY

A Lindsay-built Taylor 40 (12.2m) at Key West Race Week about 25 years ago with the builder, as he puts it, "driving the bus." Scott Smith owned and campaigned another Lindsay-built Taylor 40, which helped bring the two men together in 1990, to form the business partnership that became Boston BoatWorks. They share not just a passion for fast sailing but "all operational responsibilities" at BBW as well.

parameters, while making them strong enough for the crew to stress the sailing rig without destroying structure.

After he'd set up shop as an independent builder specializing, at first, in small raceboats, Lindsay continued to experiment with materials and methods. Precisely because the product was small, he could test many iterations within a relatively short time frame. His boats' overall success on the race course generated more and more business for him in a market niche that, though popular, was also notorious for small profit margins.

A good example of his experimental construction efforts over time came to the magazine's attention in 1996, when he was based in Gloucester, Massachusetts, as Lindsay Custom Yachts. Responding to an article we'd recently published on switching to high-performance resin systems, Lindsay wrote in to say:

"Since 1979, I have built over 50 International 505 sailboats in production female molds with polyester gelcoat and epoxy laminate, and I can attest to the challenges of innovating with construction techniques. We knew it would be hard to get a successful bond, and just kept trying until we invented a solvent and technique that usually worked. It allowed us to build very light, strong Kevlar laminates with foam and honeycomb cores, and still have a durable in-mold finish. What was a tricky process then, seems routine with today's products.

"When we started building production boats with 250°F [121°C] epoxy

prepregs in 1983, we found a whole new set of gelcoat challenges. One of the more interesting solutions was a polyurethane gelcoat developed for automotive parts. Searching for new answers is what maintains the fascination in this profession."

Additional examples of R&D that Lindsay conducted (and this magazine reported) years ago include low-cost ways to post-cure epoxy laminates, plus innovative solutions for attaching heavily loaded rigging hardware. Little wonder, then, that Bob Johnstone tapped Boston BoatWorks for his nascent MJM Yachts venture. Lindsay's many projects over many years feature fearless composite construction, with nearly all those projects high-performance sailboats.

And fortunately, BBW has been an excellent fit for MJM. In a marketing video for MJM we'll review later, Johnstone, at the helm of a 40z traveling offshore at speed in tricky seas, says in a voice-over why he selected Lindsay: "The key to more responsive handling is to build an MJM not like a powerboat but like a racing sailboat. So we turned to a builder of…racing sailboats, Mark Lindsay. Mark had been working with high-tech composites for 33 years."

A fabric impregnator is what makes wet-pregging feasible on a commercial scale, whether custom or production. Boston BoatWorks' new machine, sourced from Core Composites (see the sidebar "O'Meara's List," below), is state of the art. It's capable of producing perfectly saturated, precisely calibrated (60:40 glass-to-resin ratio, in BBW's case) reinforcement fabric faster than even an adept crew can lay down.

Lindsay and Smith recently purchased a new impregnator for BBW. The machine, designed by Rich O'Meara, head of Core Composites, a division of his Newport, Rhode Island–based ROM Development Corp., and built by Art

O'Meara's List

Rich O'Meara—whose Rhode Island–based Core Composites company was the source of Boston BoatWorks' new fabric impregnator—offered eight good reasons why wet-pregs are advantageous for composite boatbuilding.

1. *You can build a lighter boat.* That's because the core in a wet-preg lamination is not completely filled with resin, as it is for infusion processing.

2. *You optimize the fiber-to-resin ratio.* This is often expressed as "glass-to-resin" ratio; at BBW, that figure is 60:40. With wet-pregs you can also vary the ratio depending on the particular plies, from very dry (30% resin content by weight) to wetter for, say, core bonding.

3. *You control that ratio to true prepreg quality.* The deviation with BBW's new and old fabric impregnators is ±3% *or better.*

4. *You can run a range of fabric reinforcements.* From very light weight (5 oz/yd², or about 175 g/m²) up to 50 oz/yd², or 1,700 g/m².

5. *You can run a range of resin viscosities.* From 500 cps to 15,000 cps—versus infusion, "where you're pretty much obligated to use low-viscosity resins, less than 300 cps being best."

6. *You can build a boat faster than with infusion.* "By the time you load the mold with dry fabric for infusion, you can put a wet-preg laminate in place, and the resin is just where you want it. You know it's there. And, you use the same vacuum-bagging process."

7. *You do not require near-perfect molds, whereas infusion does.* If a wet-preg mold "leaks," it's not going to produce a laminate with a lot of voids. "I don't say this to encourage low-quality tooling. Rather, it's a matter of not having to justify infusion-quality molds for the potential unit volumes out there."

8. *You get very good core-to-skin bonds, once bagged.* That's because the wet-preg process offers good penetration of the resin into the core "with a laminate that—I'll say it again—has the resin right where you want it."

If the list above represents O'Meara's advantages of wet-pregs, is there a second list…of disadvantages? Yes, but it's shorter.

1. Infusion is superior if you want to fill the core kerfs to prevent water ingress.

2. Polyester resin for wet-pregs is not yet optimized by many suppliers. But that's coming, O'Meara said, because the marketplace's growing desire for lighter-weight parts requires a greater variety of fillers and of resin qualities to make them. Currently, the marine industry is "fully geared up" with low-cost styrenated infusion resins. Print-through remains an issue, so skincoats are needed.

3. Being under a vacuum bag for the infusion process is cleaner (in terms of odor and VOCs). But odor is minimized with epoxy, as is skin contact—so long as proper technique is maintained with the wet-preg process. "Spray adhesive applied to the dry stack is still the least pleasant aspect of making an infused part. That step is eliminated with wet-pregs."

—Paul Lazarus

Armellini, who operates A & E Machine Shop in Cocoa, Florida, replaces one designed and built by Bruce Pfund that Lindsay bought in 1991. (Incidentally, Pfund's article in PBB No. 99 is arguably the most detailed analysis in print, anywhere, of an impregnator at work in a boatshop. Granted, it's an impregnator from an earlier era, but by way of his objective text and richly captioned photos shot on site, Pfund tells PBB readers what the machine does best, what its limitations are, and how the BBW crew maximizes its efficiency.)

O'Meara's company, which distributes composite materials and manages composites programs, has sold more than 250 fabric impregnators into various industries since 1987, when he first witnessed an impregnator in action—in Australia, while visiting there to watch the *America*'s Cup.

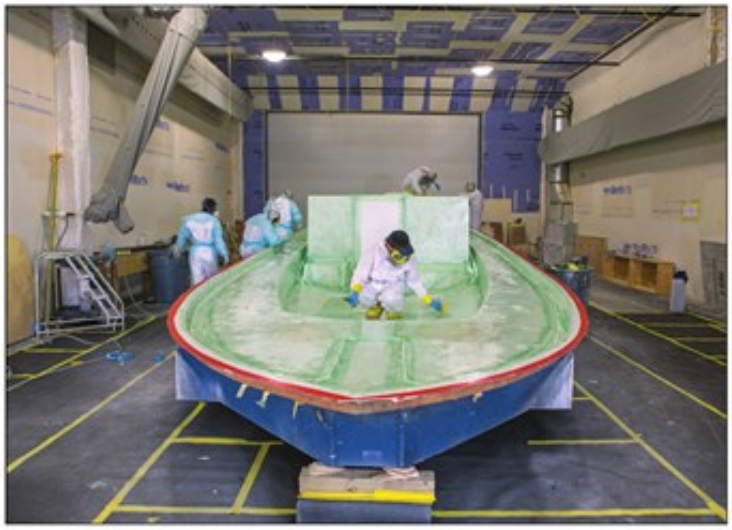
Over the next few years O'Meara tried, "with very limited success," he said, to interest production boatbuilders in the United States, among them Sea Ray and Wellcraft, in converting from sprayup to wet-preg construction. The problem, O'Meara said, was "drip issues" due to fast-curing polyester resins, and the reluctance of laminators to change away from sprayup. At the same time, "the epoxy one-off business was booming. We sold units to just about every one-off boatbuilder, it seemed, in the U.S. and Canada." O'Meara also sold impregnators to snowboard manufacturers, to outfits wrapping bridge columns, to a firm wrapping water pipes at nuclear-power plants, and to another making rocket-motor cases.

Impregnator machine design and complexity vary with the application. In the beginning O'Meara and Pfund would "compare notes on how best to build these machines," and O'Meara adopted some of Pfund's ideas into his design. O'Meara's early impregnators for the marine industry were made by Binks, best known for its spray finishing equipment.

The Core Composites machine purchased by Boston BoatWorks has the following characteristics: a 60″ (154-cm) working width; pneumatically actuated operation (via foot pedals, to keep the operator's hands free); a safety slip clutch on the drive roll (to keep fingers safe, "especially while cleaning up"); supply and take-up reels on castors; drip tray and tool trays. According to O'Meara, it's "a popular machine," and because the basic design is "simple, it has proven to be a long-lasting workhorse. Art Armellini and I have debugged it over the years, thanks to plenty of customer input."

I might add that the documentation O'Meara supplies with an impregnator is thorough and well illustrated. It covers setup, calibration, operation, and cleaning, along with a parts list and drawings. That paperwork—written in plain English—reflects O'Meara's lengthy history with these machines: he's dealt with enough impregnators to anticipate frequently asked questions, and therefore what is needed in the way of a proper owner's manual and technical support.

The top of the concrete ramp, where BBW's Travelift is parked, levels off to form a raised ground floor for the new main building. I step

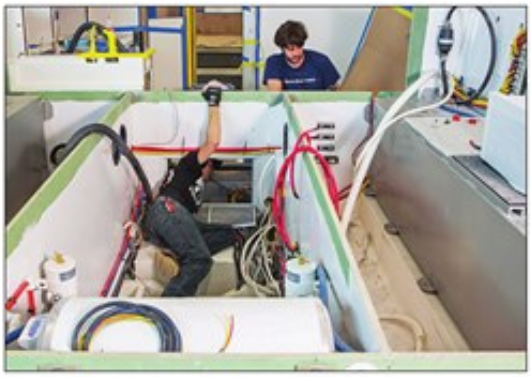


Left—*Large-part laminating and coating operations at BBW are done in a dedicated, environmentally compliant space that doubles as an oven for post-curing vacuum-bagged composites. Here, the placement-and-tailoring crew lay precut laminates—fabric and core—into an MJM deck mold.*
Above—*Another dedicated space, on the floor above, serves as the mechanicals room for maintaining air quality and optimal temperatures in the laminating room, and the assembly hall in general.*

inside a glass-walled entryway and stairwell, open an interior door, and find myself in BBW's high-ceilinged production space. The shop is humming with assembly and construction activity from one end of the building to the other.

In the old facility, Lindsay and Smith's MJM production was manageable—until sales volume, coupled with Bob Johnstone's expanded product line, reached a critical mass at the upper end of the model size range. Those boats became too big for the space available, given other boats of different sizes in various stages of construction and assembly. To build a 40-footer, for example, Lindsay and his crew had to move hulls out of the way, even out the door, and then roll them back into the shop, sometimes to a different slot on the floor. All of which amounted to unavoidable and effectively wasted time and motion. A larger shop was a necessity, not just a convenience.

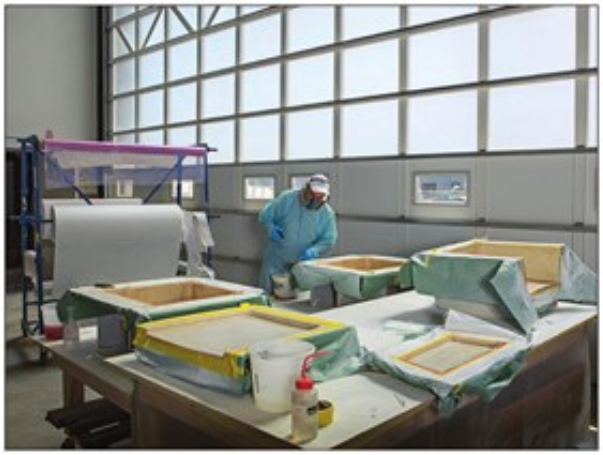
In the new facility, wet-pregging is

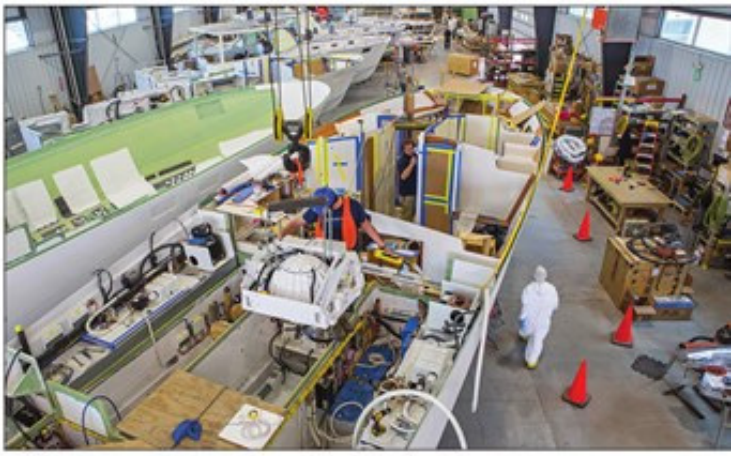


***Left**—A team of two run wire in the hull of a 50z. Fit-out for an MJM Yacht is fairly elaborate, the more so at this size, currently top of the line. **Right**—Elsewhere on the shop floor, a second team of two guide the lightweight composite house-frame into position on a 50z deck part. Within the tight constraints of the leased riverfront property under the bridge, Lindsay and Smith built a comfortable, practicable production facility to their specifications—a vast improvement over BBW's previous, much-smaller repurposed shop in an aging industrial plant across the river in nearby East Boston.*

done in a dedicated climate-controlled room/oven, whose controls are located in a dedicated mechanicals room one flight up. No need anymore to choreograph the shuffling of hulls and tooling. The rest of the build process occurs in the main space mentioned above. Lindsay likens it to the open-classroom concept in elementary education; that is, he wants BBW shop-floor personnel to be aware of what their colleagues are doing, to get a better visual idea of the many procedures involved in producing a good-size boat. He thinks of this building-hall space as fundamental to cross-training the crew, and for developing supervisors among them.

During one of two walk-throughs in this area, the first by myself and the second accompanied by Lindsay, I could see a systems installation in progress on a 36-footer (11m), two men preparing a wiring harness (one was teaching the other), another rounding a portion of the edge of a chine flat to reduce the sound of slapping

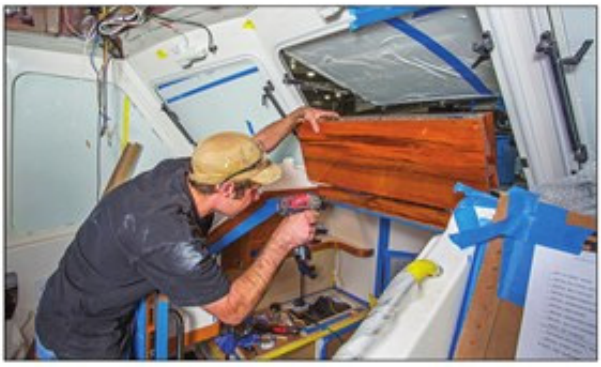




***Left**—Not all composite parts for MJM Yachts are machine-impregnated. Some, like the structural grid seen from above on page 50, are resin-infused, as are hatch covers that benefit from reusable silicone vacuum-bags. Here, in a tidy room offering abundant available light, one man lays up an array of what will be stowage compartments. **Right**—Meanwhile, out in the assembly area, a Seakeeper gyrostabilizer is carefully lowered into place aboard a 50z, where it is standard equipment—a rarity among production boats of comparable size.*

water at anchor, and several people taking delivery of a preassembled deck-railing system that had been driven from Maine, where it was fabricated by a subcontractor. Each of these tasks was likely a line item on a production wall chart in an upstairs office. Taking up the most space on the floor this morning was an infusion shoot of the monolithic internal grid to be installed on a hull was still in the oven, undergoing post-cure. The collective noise level throughout the large room was low. Similarly, there was virtually no sanding dust in the room, or fumes in the atmosphere from coatings or resin.

Indeed, Bob Johnstone promotes MJM boats, in part, on the basis of



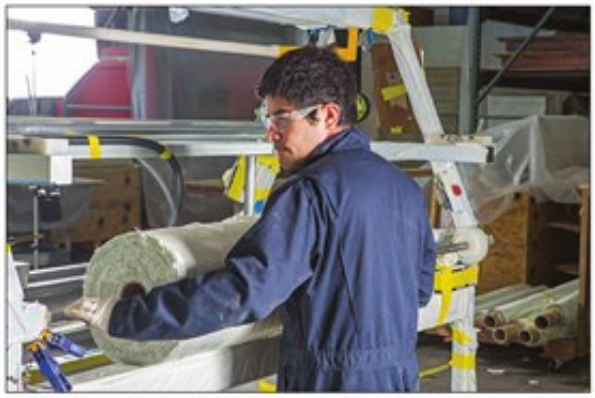
The helm station of a 50z gets a varnished mahogany lid, secured with a piano hinge. There's enough interior joinerwork on MJM yachts to keep them from feeling sterile, but not so much as to need excessive maintenance.

BBW's "green" manufacturing practices. Regarding the latter, Boston BoatWorks easily meets and exceeds the U.S. Environmental Protection Agency's Maximum Achievable Control Technology standard. Lindsay's long-held reliance on epoxy resins and closed-molding techniques not only ensures superior laminates, it eliminates the VOC problems associated with styrenated resins (in the boatshop as well as earlier in the supply chain). Locally, BBW's "record and practices related to employee health and safety" have earned it an invitation to apply for certification under the state's Safety and Health Achievement Recognition Program.

"Side benefits" to a robust safety program that qualifies a manufacturing company for the SHARP initiative, as enumerated by Johnstone, consist of lower workers' comp rates, lower product costs through higher productivity and morale, better employee retention, and lower training costs. All of which, according to Johnstone (who, let us remember, is a true master of marketing) "improves the value of MJM Yachts to their owners."

While we're on this theme, Johnstone is, I believe, sincere in his belief that MJM Yachts are "eco-friendly"—particularly in terms of energy efficiency. Text on the website for MJM Yachts points out that the 29z (8.8m), for example, "gets about 3 nautical miles per gallon [0.8 nm/l] of diesel when cruising at 25 knots. This is about half the fuel consumed by a twin-outboard center-console of the same size." Similar fuel-efficiency numbers continue up the current MJM product line to the 50z—versus other companies' production boats: trawler-yachts, express or cabin cruisers, and triple- or quad-outboard center-consoles of comparable size.

Central to the laminating of MJM hulls and decks is the fabric impregnator. Hull laminate schedules call for continuous-strand biaxial and triaxial glass reinforcement, run through the impregnator's high-pressure rollers, saturating the fibers while limiting resin content to a precise 60:40 glass-to-resin ratio. They are split hull molds, affording easy access to each half.



***Left**—Fabric for the impregnator arrives at BBW already cut to width by the vendor, which effectively eliminates ragged edges attributable to poor in-house tailoring and related distortions then caused by the machine. MJM laminate schedules specify E-glass and Kevlar reinforcements in multiaxial styles. **Right**—The new impregnator in action, viewed from another angle. Lindsay acquired his first professionally made fabric impregnator in 1991; Boston BoatWorks began building MJM Yachts with that machine, which BBW retains as a secondary unit. The challenge for Lindsay and Smith has been to continually increase production efficiency for MJM's growing line of advanced-composite powerboats.*

PVC take-up tubes loaded with the preset calibrated length of saturated fabric are carried to the tooling and manually rolled out in one piece inside the mold, the full length of the hull. After applying the outer structural laminate of fiberglass and Kevlar, crew members fit precut (by a computer numerically controlled machine) panels of waterproof structural foam (Corecell) to the wet skin. The core panels, Lindsay said, vary by physical properties according to their respective location in the hull; that is, high-load and low-load areas.

PBB To watch shop floor video of the new impregnator, go to ProBoat.com.

With the outer skin and core installed, the crew then applies the

Wet-Preg Pointers

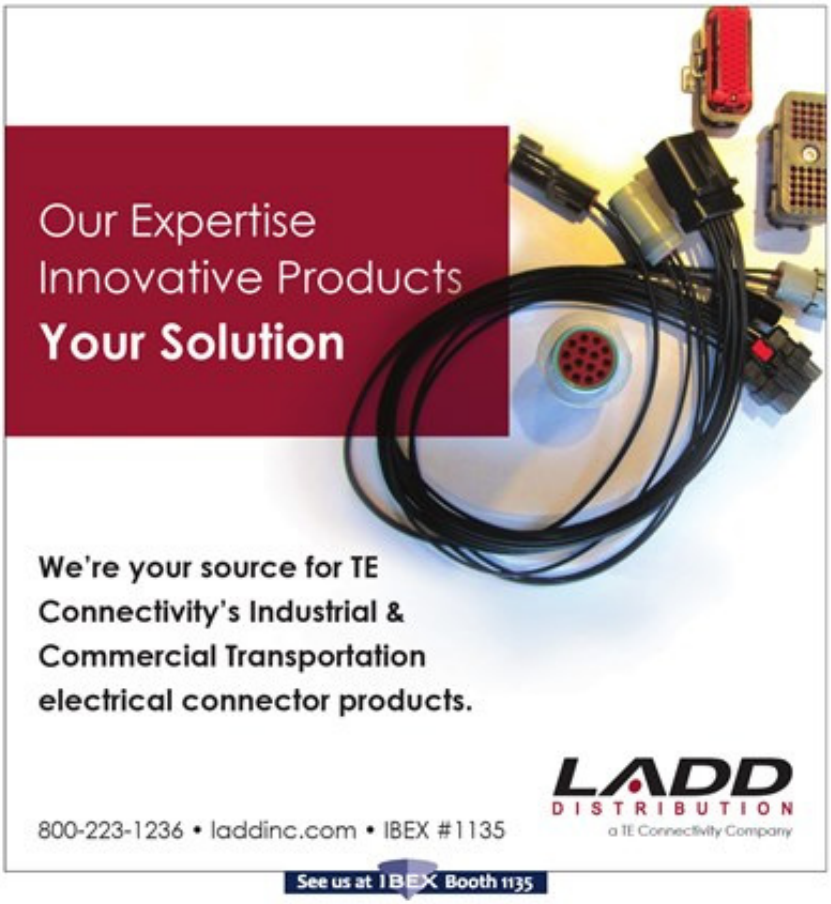
Boston BoatWorks co-owner Mark Lindsay has been nothing less than generous about sharing his technical knowledge with attendees at IBEX. He was a principal speaker at two seminars specifically on wet-pregs in *production* boatbuilding (at IBEX 2006 and IBEX 2007), and at a third seminar, in 2009, on process materials for closed-mold construction in general. Here, I've distilled the second of his wet-preg presentations to talking points Lindsay employed during his half of the 90-minute session. (In both wet-preg sessions he shared the podium with Joe Parker, longtime product manager for Pro-Set Inc., whose epoxy resin system BBW uses for building MJM Yachts. Parker is now retired.)

- *BBW chose wet-preg epoxy lamination because: epoxy gives us the highest-strength resin matrix; the wet-preg process keeps the weight low; the relatively low cost and simplicity of a wet-preg resin system in materials and process are an advantage over manufactured prepregs; and a mechanized wet-preg system provides consistent, predictable results.*
- *Higher material costs imply the need to engineer the product to gain value through the use of more advanced materials. Combining the different chemistries of epoxy laminates with polyester in-mold coatings demands careful craftsmanship and sound technology. Achieving the engineered strength properties and superior cosmetic results requires extra attention to* process *technology.*
- *When we looked at production efficiency, we discovered that the mold turnaround time was less of a*

inner layer of preimpregnated structural glass, and bags it. Under vacuum, the laminate is compressed by a pressure of 2,000 lbs/sq ft (9,765 kg/m²), "compacting the glass for ultimate strength," said Lindsay. "Then the hull halves are joined, and with 14 layers of triaxial glass we create a solid-glass centerline." Finally, the entire hull is baked for 48 hours at 150°F (65°C) before unbolting the mold halves and releasing the hull shell.

What I've written above is only an overview. Again, for a detailed description of an impregnator—and a BBW team—in action laminating a 34z, I encourage you to read Bruce Pfund's article titled "Smooth Operators," in PBB No. 99. Though the MJM 34z is no longer being built (replaced by the 36z [10.9m]), and the impregnator in that article has been supplanted by a new machine (the older one remains in use as a secondary unit), BBW's laminating process of a representative MJM hull and basic fabric-impregnator technology have changed relatively little since that article was published.

For a full discussion of the technology itself, circa 1990 but still pertinent,



concern than the total production cost of the part. Unlike the rest of the boat, the labor for the laminated parts costs more than the materials, so reducing labor hours was a primary focus.

• Resin-mixing equipment is expensive but gives us reproducible accuracy and reduces labor. A high-volume pneumatic impregnator that can keep up with the lay-down team is at the heart of our process. Precut and prelabeled core and cloth ensures accuracy and reduces layup time.

• Another opportunity was to reduce cosmetic finishwork on the parts. If you want lightweight, high-strength laminates, you don't want to waste those properties by using a resin-rich mat layer backing up the gelcoat to maintain the cosmetics.

• In addition, you'll want to cure the parts under a vacuum bag, and post-cure them at high temperature to gain the full strength of the resin system. Both of these processes, if not done right, can cause prerelease of the parts from the mold, which then means cosmetic rework.

• Vacuum-bagging demands careful attention to detail. Any place there is a bridge in the bag or the peel ply or the breather material is an invitation to causing prerelease of the part.

• The part has to reach full temperature to complete its cure. The temp must ramp up and down evenly and gradually so that the part does not pull away from the mold, or apply unwanted stresses on the laminate.

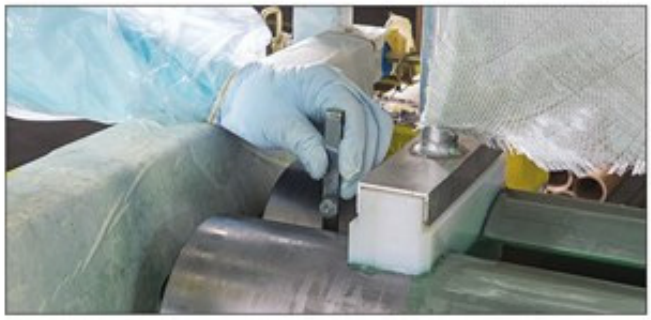
• If each step delineated above is done correctly, the result is a flawless part that will hold its shape and cosmetic perfection essentially indefinitely.

—P.L.

see PBB No. 5 for a feature article I wrote titled "Fabric Impregnators," intended as an introduction to and primer on these machines. Frankly, it surprises me that, 25 years later, so few production boatbuilders acquired them, and altered construction practices accordingly.

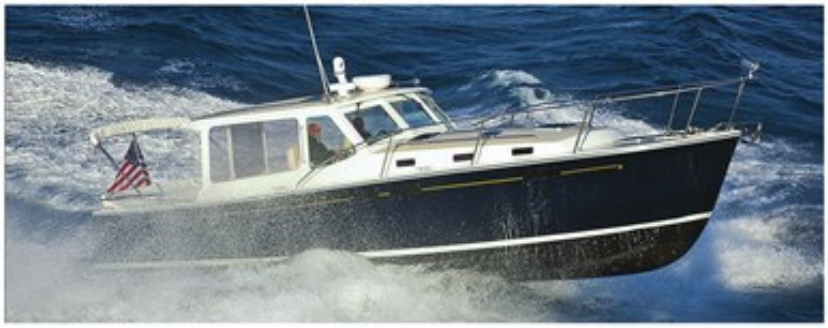
During my second walk-through of the shop floor, with Lindsay, he indicated that the boats were likely to be semi-surrounded soon by movable staging in lieu of a more permanent perimeter mezzanine system to enhance production efficiency during finishing and fit-out. We stopped at a 50z, ascended to a wooden landing, and stepped aboard by way of a door in the hull side. The largest model in the MJM product line, a 50z has proportionally larger windows in the house—necessitating beefier hardware for opening the windshield segments than the openers installed on smaller MJM models. Lindsay wanted to examine for himself the ergonomics of a potential conundrum: Would an older owner find it too difficult to open the windshield outward?

That task completed (but an Internet search for sources of appropriate hardware yet to be made), he showed



***Above**—The impregnator may have a calibration dial for it, but the operator still checks the gap between nip rollers with a feeler gauge, on the dry side of the adjustable resin dam. Irrespective of construction medium, ensuring proper setup is vital with any stationary machine-tool in a boatshop—before reinforcement starts rolling through catalyzed epoxy. **Right**—Squeegees in hand, two members of BBW's placement-and-tailoring crew make final touches to freshly impregnated fabric in the bow of a 40z, while two others do the same in the stern. Ultimately, 14 layers of triaxial glass will be applied along the centerline, joining the hull halves. Personal protective gear is worn by everyone at BBW working with epoxy.*

me a barely discernible structural detail directly beneath us, as we sat and talked under the housetop amidships. When the 50z prototype was put through builder's trials, Lindsay's experienced and educated sense of structure told him the big hull needed further stiffening. He surmised that the topside door we had passed through to board, interrupted the boat's engineered resistance to twist along the sheer. His solution was to fabricate a pair of tall, wide, light-but-strong cored composite I-beams, or webs, installed as far outboard as



A still image from a video shot by photographer Billy Black, featuring MJM Yachts founder Bob Johnstone driving a 40z to graphically demonstrate the boat's performance in significant seas on different headings. The 40z is ISO-certified "Ocean" capable, a major cut above the "Offshore" rating more typically applied to powerboats of this size.

possible in the engineroom, extending from bulkhead to bulkhead below, and beyond the break in the sheer at port and starboard topside doors. When painted to match the rest of the machinery space, this structural element resembled a traditional ceiling down below.

In a voice-over for a video made three years ago to market MJM Yachts, Bob Johnstone identifies himself as the founder, CEO, and chief boat driver. His baritone voice is pleasant, the pacing unhurried. In my opinion, no elder executive since Lee Iacocca, or Frank Perdue, has been as effective selling his product.

Johnstone is alone in a 40z, offshore, in 6′–8′ (1.8m–2.4m) seas, driving the boat at different speeds on different headings, while Billy Black—who took the photographs of Boston BoatWorks for this article—shoots video from a helicopter, like a door gunner. The boat's performance in these conditions is mesmerizing. And convincing.

Johnstone: "That's me, driving. You don't see many powerboat companies showing videos of their boats in rough water. In fact, you don't see any other boats out here today…."

And elsewhere: "When a seventy-something like me can drive a 40z from Northeast Harbor, Maine, to the Cape Cod Canal alone, in these conditions, 200 miles in eight hours, 20–30 miles offshore, you know it's easy, and safe…."

The still frame shown here from a similar video (shot offshore, in South Florida waters) provide visual confirmation of what Johnstone is describing in his narrative. His vision for an MJM Yacht—in terms of design, construction, and performance, without compromising any of those three criteria—sold boats straight through the Great Recession, as if it weren't there. At IBEX during each of those painful

years (the recreational marine industry is only now emerging from its longest and deepest slump since the Depression), Scott Smith and Mark Lindsay and Doug Zurn would attend seminars and walk the exhibit hall—smiling. Because Smith learned that while the three of them were at the show, still another newly built MJM had sold.

We've come this far in the narrative without some vital statistics. They're numbers that Mark Lindsay doesn't need to look up; the data are in his head. More important for our story, these stats testify to Boston BoatWorks being a true production builder—in wet-pregs—as distinct from the many shops turning out custom boats by the same composite process.

Having settled into its new space, specifically the 35,000 sq ft (3,252m²) of construction-and-assembly areas, BBW has seven or eight MJM yachts under way on the shop floor at any one time, depending on orders for different size models in the product line. The range in completion span between smallest, a 29z, and largest, a 50z, is three to six months. As of July 1st, Boston BoatWorks had delivered a total of 189 MJMs. Current production tempo, according to Lindsay, is about two-dozen boats per year, or "a new boat every three weeks."

Is there a long-range business plan? "As a company we're trying to maintain sustainable growth," he said. "We don't want to overinflate—and explode." Concurrent with building boats, Lindsay said that among shop-floor personnel in particular, he is attempting to build-in an awareness of key precepts guiding quality control and best practices. (The company employs 75 overall.)

The success of the MJM Yachts relationship, coupled with and predated by BBW's reputation for high-quality construction, has enabled Scott Smith and Lindsay to slowly develop what Smith refers to as a service-and-support component. Meaning, a growing percentage of MJM buyers have begun returning to Boston BoatWorks to store, repair, upgrade, or sell their boats. The phenomenon is by no means rare; several well-known East Coast yacht yards provide historical precedent, among them Rybovich, Hinckley, and Hood, to name three. This type of aftermarket activity helps account for the physical-plant expansion BBW is undertaking out back, along the riverfront beyond the rear door of the main production spaces.

And does the master builder—the older of BBW's two principals, who share all operational responsibilities—have a personal plan? Dare we say it: *retirement*? Here too, like his handling of the numbers above, Lindsay didn't hesitate: "Well-made and -engineered boats are a valuable contribution. To society, to the economy, to the advancement of technology. They're more than just manufactured 'durable goods.' I've been boatbuilding since I was kid, and still love doing it. No plan to stop." PBB

About the Author: *Paul Lazarus is* Professional BoatBuilder*'s senior editor.*