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PROFESSIONAL BOATBUILDER

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

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THE REMOTE REPAIR OF *TEAM ADVENTURE*
DRIVETRAIN FUNDAMENTALS
FACTORS OF SAFETY IN MARINE STRUCTURES
MORRELLI & MELVIN DESIGN & ENGINEERING

M&M

The California firm of Morrelli & Inc. specializes in multihulls.

Gino Morrelli discusses the origins of the company

by Steven Callahan

Within months of her launching in 1998, the 125' (38m) mega-catamaran *PlayStation* proved herself to be not only one of the fastest boats ever created, but also one of the scariest. Just prior to a record 24-hour, 580-mile run offshore (a record since broken), the boat's 5,300-sq-ft (492.39 sq m) mainsail sucked a crew member's finger into the reefing outhaul block and nipped off the end. And during The Race, a no-holds-barred sprint around the world that began in January 2001, *PlayStation's* sails blew apart; also, a collision with flotsam sheared off one of the centerboards, forcing her to withdraw. *(Club Med,* another giant catamaran, won after just 62 days of sailing.)

PlayStation was hardly alone in hanging designers and sailors from a precipitous learning curve. All the big cats in The Race, including the finishers, suffered mishaps of major proportions. The unluckiest, Pete Goss' *Team Philips,* first lost 60' of one bow, then dislodged a maststep, and finally was abandoned at sea prior to the start.

Such structural and performance problems were probably inevitable. Why? Because never before had catamarans been scaled up to such a degree: two lanky hulls tied together with a few crossbeams and driven by as much sail area as they can withstand. *PlayStation's* 7,274 sq ft (675.77 sq m) of upwind sail—the mainsail alone weighing 1,700 lbs—produces

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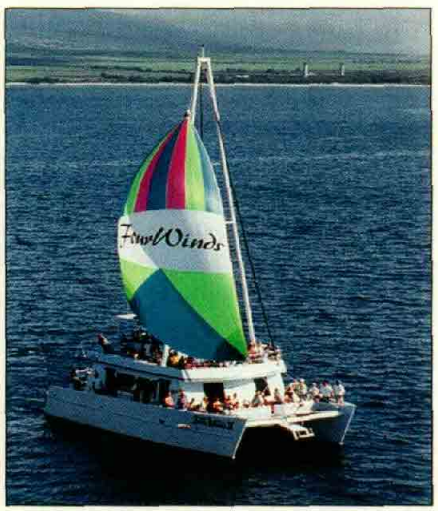
CHRISTIAN FEVRIER

PlayStation *is perhaps Morrelli & Melvin's most ambitious project to date. A 125' (38m) x 60' (18.3m) composite Supercat, she's designed for open-ocean racing (and recently broke the Miami-to-New York sailing record). Even though the boat was engineered with the benefit of extensive finite element analysis, no one could predict the actual severity of the loads that* PlayStation's *structure and rig have experienced at high speeds in rough seas.*

Melvin Design & Engineering
Every kind of multihull.

Pete Melvin comments on powercat performance



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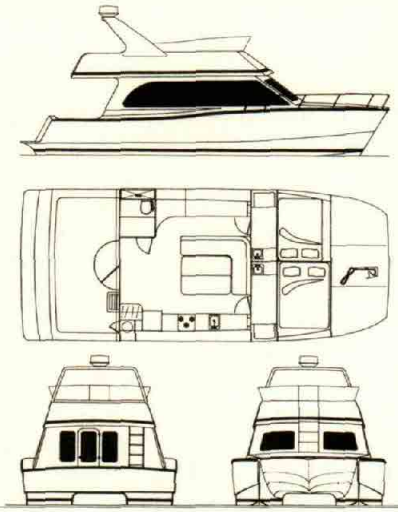

There is great range to M&M's portfolio of powercats, only a sampling of which is shown here. Clockwise from lower left: a 20' (6m) planing powercat, which serves the firm as a test platform for the type, including hydrofoil research. •Fifty-five-foot (16.7m) passenger boat fitted with an innovative A-frame rig, and operated by Maui (Hawaii) Classic Charters. •Thirty-five-foot (10.6m) custom motoryacht. •Sixty-five foot (19.8m) 150-passenger vessel, built for Pacific Whale Foundation and used for whale watching; the boat cruises at 19 knots, with a maximum speed of 24 knots, powered by twin 430-hp diesels.

When determining the optimal hullform for any new powerboat design, it is imperative that the designer know the weight, speed, length, and powering options for the proposed vessel, since these variables are key to its success. Longer, lighter boats operating at moderate speed are excellent candidates for a *displacement* catamaran hull; shorter, heavier, and faster boats are better off with a *planing* catamaran hull shape.

Displacement Catamarans

A displacement powercat can be distinguished by its narrow hulls and generous clearance between the water and the underwing. That clearance prevents waves from hitting the underwing, which can force the boat to be driven slower than desired. In terms of performance, displacement powercats are most efficient at speed-to-length ratios of less than about 4 and are the most common type of powercat over 40' in length. In order to realize the performance potential of a displacement powercat shape, displacement should not be too great for the length of the hull.

Displacement powercats offer one of the smoothest rides of all powerboats.

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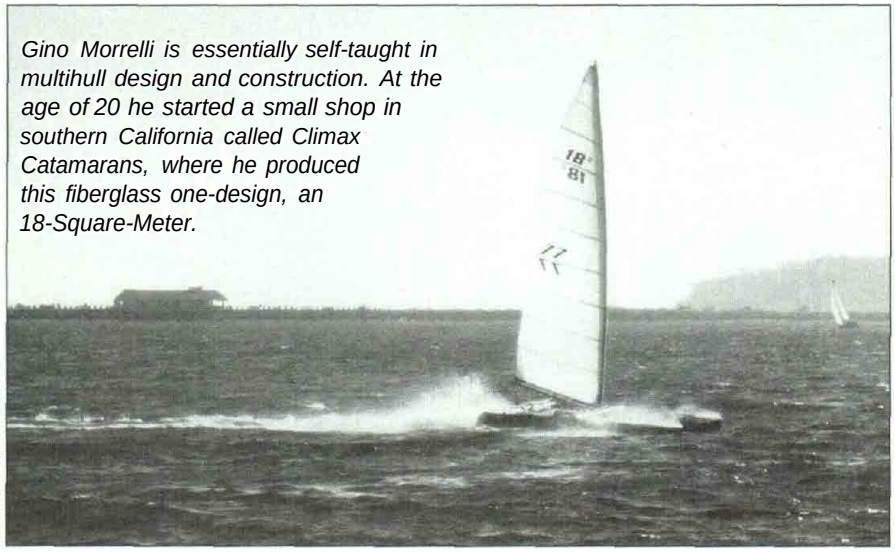


Gino Morrelli is essentially self-taught in multihull design and construction. At the age of 20 he started a small shop in southern California called Climax Catamarans, where he produced this fiberglass one-design, an 18-Square-Meter.

COURTESY GINO MORRELLI

30,000 lbs of tension on the mainsheet, 32,000 lbs on the shrouds, and 110,000 lbs of mast compression. No one knew if eyes might literally fall out when the 125'(38m)-long. 60'(18.3m)-wide platform began slicing through and slamming across huge and complex wave patterns. The boat's structure had to be designed to handle routine flexing that would wrack one bow up to 12' (3.6m) above or below the other, yet be stiff enough to keep the 147' (44.8m) mast upright. Few people in the world had enough experience to create such a vessel, but betting men gave the bold design from the Newport Beach. California, office of Morrelli & Melvin some of the best odds—for good reason.

Gino Morrelli grew up less connected to sail than to slant-sixes. His dad built stock cars and dragsters in their home garage. While the patriarch raced in west Texas on weekends, the family stayed in the pits. After moving to Irvine, California, in 1970 when Gino was 13. the Morrellis bought a Columbia 24. "The thing was so slow that going to Catalina Island was about a two-clay affair." recalls Gino. "Considering a bigger boat, we thought, 'If we can build a car that can go 180, we can probably build a boat that will go 10.'" In a backyard-builder heyday, and unfettered by yachting tradition, the Morrellis purchased plans for a demountable 33' trimaran ideally suited to their tight home shop. By his junior year in high school, Gino had earned enough academic credits to allow him to take five shop classes a day; he "worked out a deal" with his shop teacher that allowed Gino to spend time finishing the trimaran at home. Toward the end of his senior year, the Morrelli family returned to racing, this time on liquid courses. "My mom and clad let me and my brother deliver the boat up and down the coast to races. It was a great experience."

Soon, Gino's brother Tony had built a wooden A-class cat in the garage. To help iron out its flaws, Gino built his own. Then Tony bought a prototype 18-Square-Meter catamaran from Tom Roland, creator of the then-revolutionary NACRA beach cat. Not to be outdone, Gino "conned a guy to go in with me to build molds for my own fiberglass 18-Square." Others heard about the operation and told him, "As soon as you get this built, if it's decent. I want another set of hulls." So. Gino bought out his partner, rented a shop in Huntington Beach, hung out a sign that read "Climax Catamarans," and started building 18-Squares. He was 20 years old. "We survived by word of mouth and hand to mouth, but it was fun, and my version of going to college."

At the time, the only production boat that employed honeycomb cores and baked epoxy hulls was the 27' (8.2m) Stiletto cat, but soon Morrelli was splitting cases of Nomex with a couple of progressive International 505 builders in the area, eventually laying up hulls using honeycomb core, two plies of Kevlar, carbon ribbing, and epoxy—all vacuum-bagged. For several years, Morrelli and the competition leapfrogged one another. His first boat made with mat and roving weighed 400 lbs and sold for $3,500; four years later, an 18-Square weighed just 180 lbs and cost $18,000. "They'd gone from being fun and bomb-proof to tweaky and super fast." he says.

When the boatbuilding industry stalled on soaring petroleum-product prices in the 1970s, Morrelli closed shop and spent a year on a charter cat in Hawaii. Then, a former 18-Square customer persuaded Morrelli to return to Huntington Beach to produce his first big boat, the 45' (13.7m) *White Knuckler*—a female-molded, vacuum-bagged, unidirectional S-glass and vinyl ester catamaran that promptly won the prestigious Ensenada Race.

In Europe, particularly in France, offshore sailboat racing had become completely professional, with multi-million-dollar sponsorship contracts for skippers whose celebrity status rivaled that of rock stars. Pumped up to do another big boat, Morrelli headed for Louisiana, for the finish of the La Rochelle (France) to New Orleans race that featured the Atlantic's newest and hottest 60' (18.3m) to 80' (24.4m) multis. "The sponsors were enamored of composite cats because *Charente Maritime* had just won the race, beating Marc Pajot's old aluminum truck, *Elf Aquitaine,"* says Morrelli. But even Patrick Morvan's composite-built, record-breaking *Jet Services,* which would soon traverse the Atlantic in a record eight-and-a-half days, looked crude to Morrelli. After Morvan saw *White Knuckler,* he asked Morrelli to sail back to France and build a new Gilles Oilier design at Ollier's Multiplast yard (currently the premier multihull operation in France and one of Morrelli & Melvin's chief competitors).

Morrelli, however, remained patient, and was rewarded with a carte-blanche offer to design and build a 60' (18.3m) cat at a sponsor's factory near Paris. "Right out of this factory where they produced prefab steel buildings, we took welders, carpenters, and other tradespeople who knew nothing about boatbuilding, and built *Region de Picardie* using Nomex honeycomb core and Kevlar/carbon skins." A year-and-a-half later, the boat began beating all comers save the 80'*Royale,* including the second-generation *Elf Aquitane,* now a radical, all-carbon, wing-mast-

PHOTOS COURTESY GINO MORRELLI

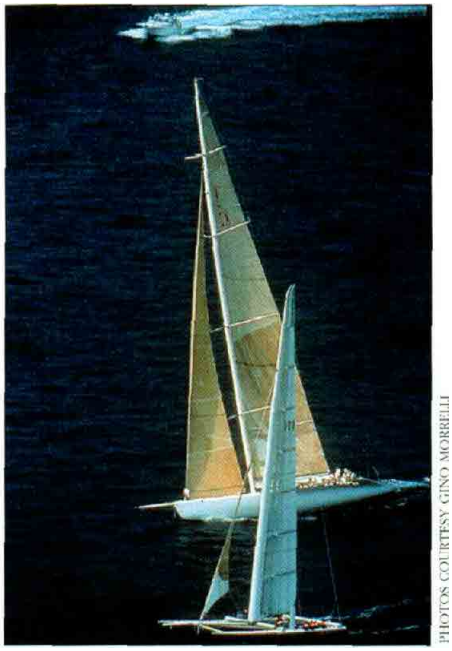
As Morrelli's talent, confidence, and reputation developed, his boats got bigger, more daring. The aptly named White Knuckler *(above) was his first large commission—a 45' (13.7m) female-molded, vacuum-bagged, unidirectional S-glass and vinyl ester cat. She won the prestigious Ensenada Race, right out of the box.* Region de Picardie *(right), a 60' (18.3m) Nomex/Kevlar/carbon cat, was built by Morrelli in France with a pick-up crew. He actively campaigned her in the early 1980s against tough European competition, until injuring himself (and damaging the boat) in a Round Europe race. The fully repaired* Picardie *is current/y in charter service in the Caribbean.*

driven multi skippered by Marc Pajot, the winningest captain of the era. "We caused quite a stir, because we came out of nowhere," says Morrelli.

But *Region de Picardie* was unable to win the 1984 Observer Singlehanded Transatlantic Race (OSTAR). Then, in the inaugural Transat Tag race from Quebec, Canada, to St-Malo, France, she suffered another setback. Running downriver at night, Eric Tabarly's aluminum toiler *Paul Ricard* clipped the light off the top of a buoy with its crossarm. Ten minutes later at double-digit knots. *Region de Picardie* center-punched the buoy and snapped her forward beam.

"By 1985," recalls Morrelli, "Nigel Irens' trimaran *Apricot* was kicking everybody's butt. As we chased Nigel around Europe, usually placing second or third, we discovered that we were too wide, especially for inshore racing." Narrower cats from Oilier and other shops maneuvered smartly, and quickly flew their weather hulls—which made them far more stable and controllable than small beach cats, and it reduced drag. Shorter beams and smaller loads also saved weight. The final blow for *Region de Picardie* came on the last leg of the Round Europe series from Toulon to Sardinia in a mistral of 35 to 45 knots. *Fleury Michon* had broken her forward beam. An hour later, under chute and reefed main with Morrelli steering from out on the beam. *Region de Picardie* turned downwind in steepening seas about 25 miles from the start. In a big wave, she buried her bows up to the mast and tipped on end. Morrelli found himself hanging from a horizontal runner until the fully eased sails and mast hit the sea, shaking him off. "I fell about 30' and landed feet-first onto the mainsail, which was stiff Dacron, fully battened, and lying on the water like a piece of plywood," he remembers. As the boat's forward beam snapped and her mast toppled, she completed the pitchpole. Morrelli ended up in the hospital for four weeks with a compression fracture of his fourth vertebra. "It improved my French quite a bit," he says. *Region de Picardie* retired to the Caribbean where she has since served successfully as a charter boat.

In the mid-1980s a new professional multihull circuit was heating up in Europe. The Formula 40. or F40 for short—a relatively open development class limited by little more than length, sail area, and a minimum weight—promised to reduce sponsors' costs while boosting spectator appeal, because they could race in harbors but were still big enough to compete offshore. F40s sometimes even passed monohull Open-class 60s and 80s. When American Olympic medalist Randy Smyth found money for an F40, Morrelli had just months



PHOTOS COURTESY GINO MORRELLI

In 1986, Morrelli created a very successful Formula 40 ***(above, left)*** *for multihull racer Randy Smyth. The F40, a then-new open development class, presaged* Stars & Stripes, *Dennis Conner's boat in the controversial 1988 defense of the* America's *Cup, in which Conner's 60' (18.3m) cat completely dominated the New Zealand challenger, a monohull twice its size* ***(above, right).*** *Morrelli was a key member of the* Stars & Stripes *design team.*

to complete it before the beginning of the 1986 circuit. Morrelli showed his natural bent for practicality by simply-putting a dam in *White Knuckler's* mold and spreading the sections out to gain buoyancy. "At first, everyone cleaned our clocks, but with Randy driving, and Cam Lewis [an American racing sailor who recently skippered *Team Adventure* in The Race] pulling strings, and a local star like Yvonne Faconnier giving local knowledge, and me babysitting to make sure it stayed in one piece, *Smyth Team* won the championship," Morrelli says. "With 18-Squares and *White Knuckler.* we'd basically been developing Formula 40s, especially the rigs, for years before Formula 40s existed as such." While the competition had tried to scale clown big, offshore boats, Morrelli had, in effect, "scaled up a Tornado." an Olympic class. *Smyth Team* was the only boat built to the minimum weight specified by class rules, but suffered no structural problems and carried an enormous and efficient mainsail—almost a "unarig," with quick and powerful hydraulic sheeting. A tiny jib fulfilled the storm jib requirement.

Morrelli produced two carbon/foam-sandwich F40s for the 1987 season. Although these boats were even lighter and stiffer than *Smyth Team.* the competition had cloned his winning rig, and Irens-designed cats gained power from slanted, lifting, foil daggerboards. Also, trimarans such as *Biscuits Cantreau,* designed by van Peteghem and Lariot-Prevost. had come of age. "For the same weight, physics gives tris the advantage," says Morrelli. "In heavy airs, their wider stance gains righting moment. In light airs, crews can fly two hulls for about a 20% advantage in wetted area. The problem is cost. We built *Smyth Team* for 200 [thousand]-something, the next boats for 300-sotnething. *Biscuits Cantreau* cost 500-something." Also, a broadened circuit demanded more disassembly, trucking, and reassembly. With costs escalating, the whole thing collapsed and eventually mutated into a race series on Switzerland's lakes, where Morrelli would soon make his mark.

Back in the world of "conventional" big-bucks racing, New Zealander Michael Fay was challenging for the 1988 *America's* Cup with a 120' (36.6m) monohull. Dennis Conner's syndicate wasn't sure what it could build in time to defend the Cup. and spent months battling Fay in court. "By the time Conner's group decided on Plan B, they were throwing the names of every multihull designer-builder in the United States into a hat," says Morrelli. "In a funny meeting where they decided 'This guy's a complete whacko, this one's marginal,' we came up marginal. Duncan MacLane and Dave Hubbard of C-class fame were also on board, as was Bernard Nivelt. Bruce Nelson and Brit Chance were the real designers who could oversee us wing nuts." The Conner syndicate also engaged the services of marine software experts John Letcher and Clay Olliver.

"We quickly learned from Dennis that sail area is God. Weight matters less than putting up as much sail as you can." says Morrelli. "MacLane and Hubbard at first were optimistic about a rigid wingsail without headsails—totally clean, with no winches on the beam, like a pure C-class cat. But Dennis kept saying, 'Bullshit—this thing isn't going to go downwind.'

"So, we drag-raced our F40 against 'H1', the so-called hard-sail version of the 60' [18.3m] A-Cup cat we'd designed. At the upwind mark. H1 led by 12 minutes. But by flying big flat reachers and tacking downwind, the F40 passed it and won by three minutes. That convinced Dennis. H1 became *Stars & Stripes:* we put a big rigid wing on her—but added headsails." Morrelli figures a wingsail plus headsails delivers an overall advan-

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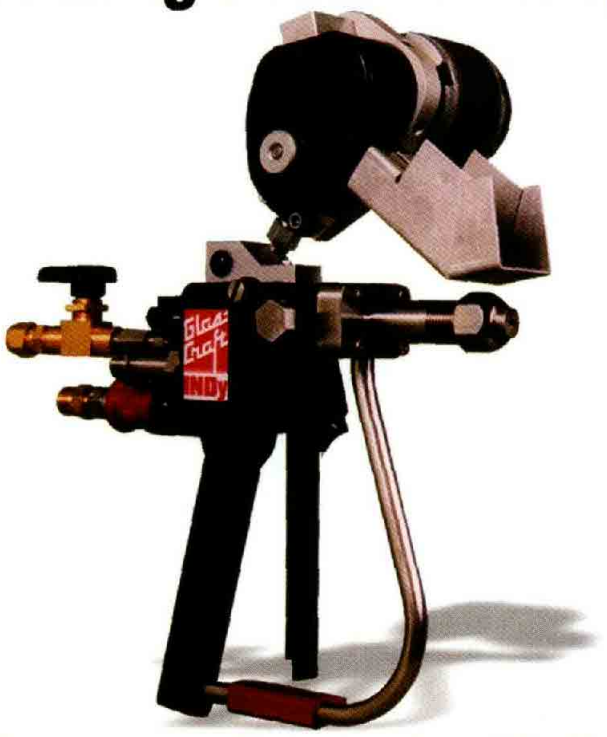

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Pete Melvin and Team M&M

The main text might give the mistaken impression that Pete Melvin is a somewhat silent partner at M&M. Actually, he happened to he away at the time author Steve Callahan visited the Newport Beach, California, design office, so Gino Morrelli did most of the talking for our story on their firm.

While not a gregarious individual. Melvin is not shy, either; he's given strong presentations at *Professional BoatBuilder's* IBEX seminar programs on various technical aspects of multihulls. And for someone as highly decorated as he is in sailing competition—17 national championships and two world championships, in addition to representing the United States in the Tornado catamaran class in the 1988 Olympics—Melvin is a modest guy. His most recent triumph was the North American A-Class championship, won in May with all first-place finishes on an M&M design. That same month he was part of the crew aboard *PlayStation* when she broke the Miami-to-New York record under sail.

Melvin's involvement with boat design and construction elates to the early 1970s, when he and his father built a range of championship Optimist dinghies. He also says they were among the first builders in the marine industry to use carbon fiber and honeycomb core in a hull—a claim not easily disputed, considering Melvin's formal education in aerospace engineering. After college and before joining McDonnell Douglas in southern California for a five-year stint as an advanced-design engineer on commercial and military aircraft projects, Melvin worked for Mark Lindsay, a Massachusetts-based boatbuilder with a wealth of knowledge about advanced composite construction. (Lindsay is currently a principal of Boston Boat Works.)

Now nearly 10 years into their partnership, Gino Morrelli and Pete Melvin have settled on an informal division of labor. "Gino handles many of the sailing customers," Melvin says. "and I manage most of the powercat and production (sailing] cat projects. I think if I've specialized in any one thing here it would be in developing good engineering methodologies.

COURTESY PETE MELVIN

Pete *Melvin—hiked out on a trapeze on a highly competitive A-class beach cat designed by M&M—loves to race. He holds 17 national and two world championships, and was an Olympian in a Tornado-class catamaran in the '88 Games.*

"As our firm has grown larger," Melvin continues, "we've come to rely more on our associates executing the various individual elements that together make up a successful design. Ours is no longer a two-man operation, and our designs have improved significantly thanks to this crew."

That crew consists of: Robert Favier, responsible for most of M&M's stability analysis, 3D renderings and animation, general programming, and the person in-house who maintains the company computers and networks. Favier's been at M&M for four years. Then there's Tim Kernan, who, says Melvin, "excels in arrangements, structural analysis, and 3D modeling." Kernan joined M&M a year ago, after five years with designer Bob Perry in Seattle. Other members of the team include four-year veteran Diane de Witte, who takes care of marketing and the firm's Web site. De Witte, by the way, holds a U.S. Coast Guard 100-ton license, delivers boats, and teaches sailing. New to the shop is Carlene Morrelli, account manager.

Although everyone at M&M understands and appreciates the press garnered by their big boats, particularly *PlayStation,* the fact remains that M&M continues to be a leader in the field of production racing and recreational catamarans, an area of special interest to Melvin. "Many ideas that come from our design experience with these smaller boats end up on the bigger boats," he says. "The A-class and F-18 are excellent test beds for new hull shapes, foils, and rig concepts." Melvin cites five designs among the smaller craft that deserve mention:

- The Hobie Wave, Hobie Cat's best-selling sailing cat for the past six years;
- The Escape PlayCat, a 16.6'(5m) rotomolded recreational sailing cat that debuts this season;
- The A-class cat—18' (5.5m) x 7.5' (2.3m) with 150 sq ft (13.94 sq m) of sail area and a minimum boat weight of just 165 lbs (75 kg)—a fast favorite of singlehanded sailors, which has become a very competitive international development class. M&M introduced a new design in '97 that won the world championship that year (sailed by Melvin) and the North American championship five times;
- The Inter 18/Formula 18 class catamaran, another competitive development class, this one in Europe. Since its introduction in '96, M&M's Inter 18

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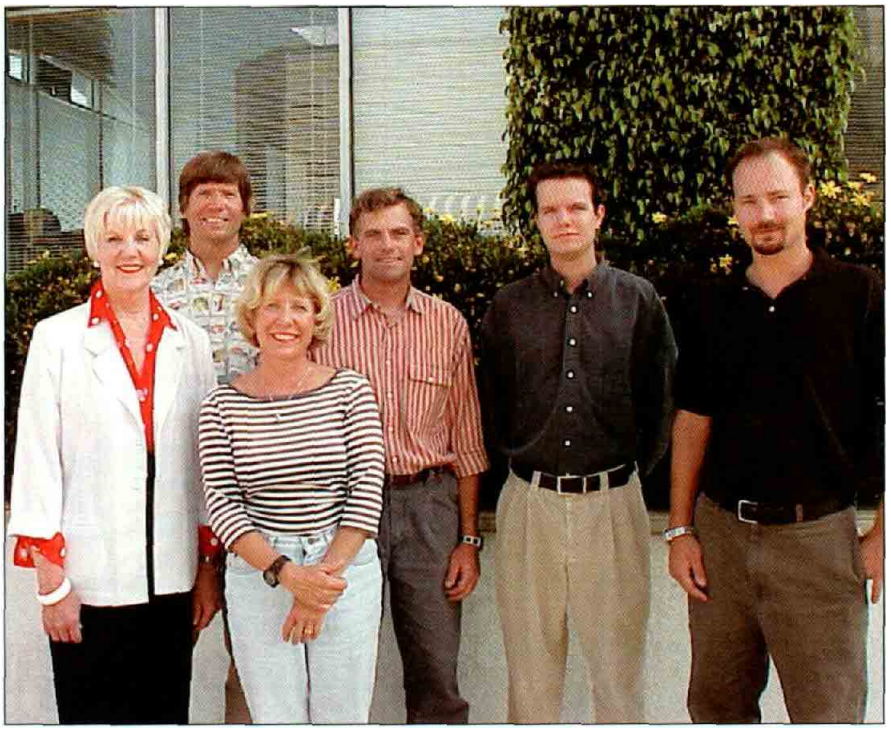


MORRELLI & MELVIN

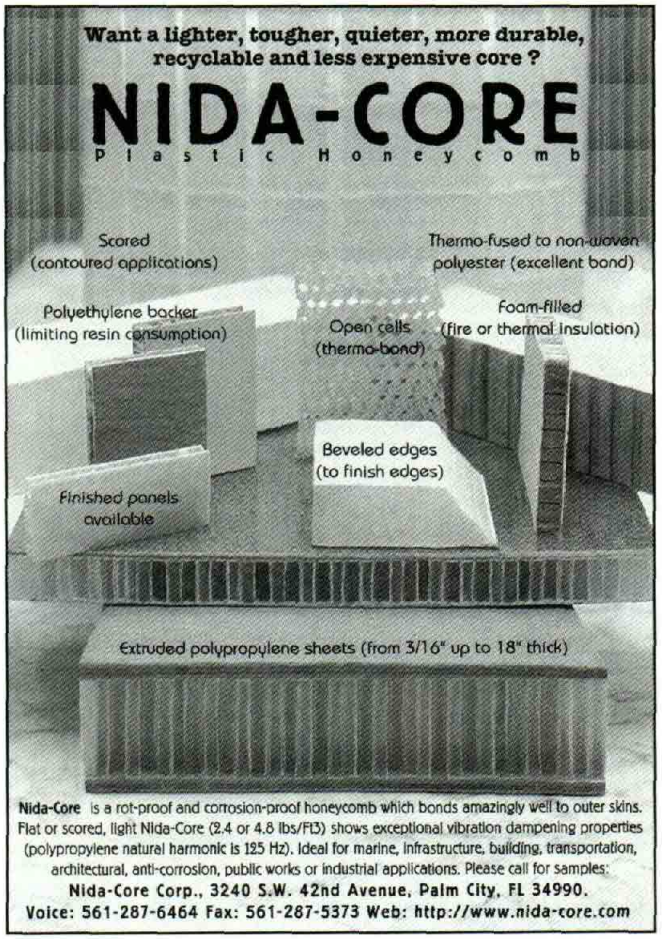
The M&M staff outside their offices in Newport Beach. Left to right, Carlene Morrelli, Gino Morrelli, Diane DeWitt, Pete Melvin, Robert Favier, and Tim Kernan.

design has won most major events several times;

• The Ventilo Formula 20 racing cat. This design was introduced in 1990 and has won the Formula 20 world championship every year since.

An unusual but not inappropriate job taken on by the M&M office in early summer has been a re-design of the interior arrangements for *Bounty*, the legendary 1930s ocean racer designed by the late L. Francis Herreshoff and now located in southern California; the yacht was extensively damaged in a fire. As indicated in the main text, much of M&M's practice today consists of powercats, so that's where Pete Melvin is focusing his efforts. He's done enough research to draw valid technical comparisons between powercats and monohulls, including recent work exploring the effect of foils on a powered multihull. A synopsis of some of M&M's studies appears on page 85, written by Melvin.

—Paul Lazarus, Editor



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GINO MORRELLI

Two versions of Stars & Stripes, *known as H1 and S1, competed for the chance to defend the* America's *Cup in '88. H1 had a rigid wing, while S1 wore a "soft," or more conventional, sail rig. In the end, Dennis Conner chose to hybridize the two by adding headsails to H1. Gino Morrelli and Pete Melvin first worked together on an unsuccessful Little* America's *Cup campaign-—an ultra-lightweight C-class cat rigged with a rigid wing.*

tage of about half a percent over a standard rotating wing with headsails. Surprisingly, the wing was also less prone to breakdowns and less needy of tweaking than the alternative "soft rig" for *Stars & Stripes:* a rotating mast and regular sails. The latter setup often tore the clews out of the mainsail or blew up hardware.

The U.S. catamaran victory over the New Zealand monohull was a foregone conclusion, and Morrelli acknowledges that Conner purposely dogged *Stars & Stripes* to make it look more like a race. "It's absolutely true. That's the thing about a rigid wing—it doesn't luff," admits Morrelli. "They didn't want to come in under the hour-and-a-half record-setting winning time set early in the 20th century. That became part of the court case; the boats had to be reasonably competitive. The reality was that the Kiwis built a fairly conventional monohull with all kinds of problems. They were trying to keep it together, and still the boat went sideways. In the end, we could have raced a Formula 40 against the Kiwis. Our program was way overkill. Either the soft rig or the hard rig would have destroyed the Kiwi boat."

Even so, *Stars & Stripes* was far from

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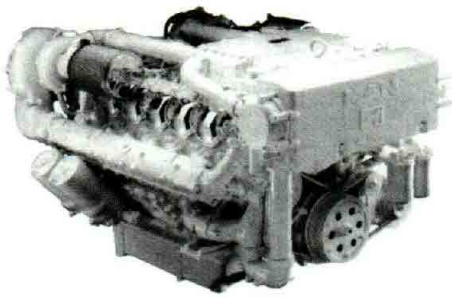


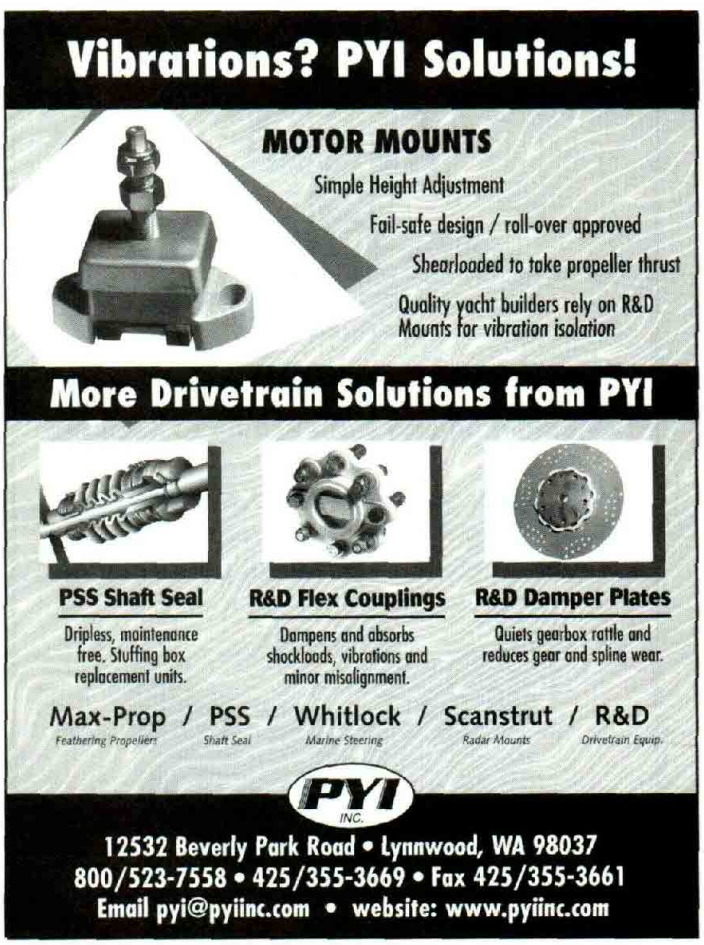
ideal. Based on their offshore experience. Morrelli and Nivelt lobbied for a more voluminous platform, while others wanted to mirror the low-freeboard, slim-ended C-class cats that carried solid wings. *Stars & Stripes'* wing had scaled up much heavier than expected and was lengthened, as well. "The boat ended up a lot pitchier," says Morrelli. "We dragged the aft beams all the time, and pounded the front beams regularly."

In the early 1990s, the combination of a luxury tax and recession was crippling much of the recreational marine industry. Morrelli met Pete Melvin, a McDonnell Douglas engineer who was racing Hobie 21s but wanted to move up to one of Morrelli's F40s to race in the short-lived American ProSail circuit. Brian Bilbray, a multihull fan and Conner backer, had enticed Morrelli with the prospect of a Little *America's* Cup campaign, sailed in C-class catamarans; Pete Melvin offered proven sailing prowess, engineering skills, and valuable aerodynamics contacts at McDonnell Douglas with whom the team could design a wingsail. "In my experience," says Morrelli, "engineers usually aren't that flexible. Their training teaches them formulas. But until recently we haven't had any idea what the real loads are on these boats. For years, guys like me had gotten away with murder by building a boat and, if we broke it, fixing it or improving it so it wouldn't break again. Pete had enough boating experience to temper his expectations with what happens in real life." Melvin quit his job at McDonnell Douglas, and the newly formed Little *America's* Cup team went into action.

"Unfortunately," says Morrelli, "our program was a dollar short and a day-late." Morrelli and Melvin et al. faced the seasoned C-class champions: Lindsay Cunningham's, team from Australia, with their *Yellow Pages.* "We were able to take one race and lost another by a meter, but broke our boat in a third. It was a calamity. A good learning experience, sure, but a financial disaster. And I now had an eight-month-old baby."

[For a close look at a recent and successful C-class catamaran of American design and construction, see PBB No. 39, page 30. For more about Pete Melvin's professional and racing background, see the sidebar on page 90*—Ed.]*

Fortunes change. Gino Morrelli soon picked up a commission for his first lake racer. Pete Melvin was considering going out on his own, but "since he was actually making more money than I was at the time, it seemed a good time to make him a partner," says Morrelli. "So Pete took a pay cut and within a year or two we were generating a lot more work." In the decade since, powerful relationships formed during racing campaigns with velocity-prediction-program specialist Clay Olliver, finite element analyst Kurt Jordan, and speed-savvy engineers Phil Arnold (Cabo Rico Yachts) and Greg Ketterman (Hobie Trifoiler) have allowed Morrelli & Melvin to create some of the most progressive and technically advanced multihulls in the world. They've become best known for their Lake



COURTESY OF M&M DE CERVOS

M&M has designed imposing, technically advanced trimarans—such as the 41' (12.5m) pre-preg carbon Alinghi*—that compete in a special race series on Switzerland's Lake Geneva. Their immense sail plans enable these boats to accelerate quickly with minimal wind. The central hull carries the primary rig loads.*

Geneva trimarans and the goliath *PlayStation.* Simultaneously, they've catered to an expanding market for *power* catamarans, both recreational and commercial.

Their lake-racing trimarans feature extreme beam and huge floats that have grown from a maximum of two-and-a-half times to four times the boat's displacement. These provide great righting moment and generous freeboard, which keeps the connective high above the water, places winches at convenient heights for crew standing in the grinding pits, and increases the hulls' longitudinal stiffness. The central hull carries primary rig loads and allows the boat to tack quickly. M&M get away with chopped-off transoms because six crew hike out to keep the leeward hull from immersing much in very light airs. In just eight knots of true wind, the immense rigs have accelerated the boats to 12-plus knots, at which speed the wakes no longer collapse in on themselves. Everybody then moves to leeward to encourage flying the weather float and main hull. Wide, shallow sections and almost-flat rockers encourage liftoff. High speed shifts the apparent wind so far forward that these craft tack most efficiently in about 100°, but with flat sails and daggerboards toed in at about 1.5" and drawing as much as 10'(3m), the boats sail within 19° of the apparent wind and make just a few degrees of leeway.

M&M constantly struggle to keep such extreme boats together. "As soon as we think we have it sorted out, we

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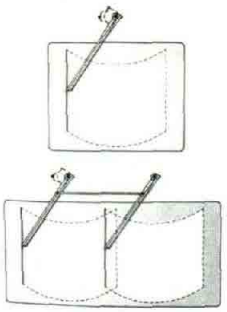

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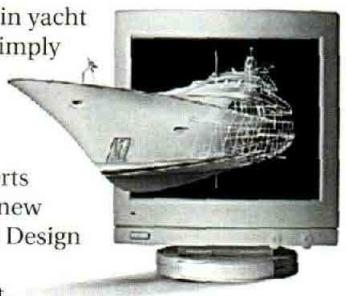

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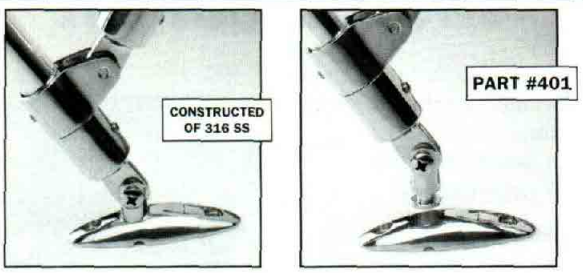
go from Spectra cloth to carbon to 3DL, and the rigs just keep getting bigger and lighter," notes Morrelli, recalling one spectacular fold-up when a foot of one boat's bow got yanked off *by* the loads involved.

Still, no structural challenge could have been greater than creating *PlayStation.* According to Morrelli, surprisingly little was spent on platform shaping, and none on tank tests. "For most applications, as long as you don't overthink the problem or get the displacement horribly wrong, you can't screw up cat hulls." says Morrelli. M&M optimized *PlayStation's* seakindliness by using elliptical shapes through the midbody—"real soft" sections, in Morrelli's words, that retain a faint keel line aft; and high-prismatic, full ends (typically .68 to .72 on their boats). "All the value is in the rig and structure," he continues, "which can dampen pitching more than hull shaping. As a design firm we believe you should pour money on a boat from the top down. I'd rather have a carbon mast on an aluminum boat than vice versa."

PlayStation benefited from extensive finite element analysis. Says Morrelli, "With the *America's* Cup campaign, we learned FEA's limitations, but it can help the boat come-out of the box really fast, rather than working on it for three years to make it fast. For *PlayStation,* even though we'd budgeted a fair amount of money for FEA, we soon realized just how useful it was, so we slowed the whole design process down. We'd hardly finish designing a part before we FEA'd it." Kurt Jordan's FEA expertise, augmented by seagoing experiences from Morrelli, Melvin, and *PlayStation's* skipper and watch captain, helped transform FEA from a black art to an indispensable tool. Jordan developed huge FEA models of the entire structure withstanding, in Morrelli's words, "your worst nightmares: dropping off a wave onto the opposite bow and stern at 2 g's; pitchpoling with the bows 40' underwater and suffering enormous hydrodynamic pressure; twisting; and so on. By moving material from 'cool' spots to 'hot' spots [color values that correspond to structural loads in an FEA rendering], we didn't really reduce the weight of the platform, but we *were able* to arrive at a much more homogeneous safety factor for all the worst cases. And, we hoped these would handle all the smaller ones we hadn't thought of."

Experience seems to have confirmed M&M's approach and assumptions. *PlayStation* has suffered no structural failures, despite a near-pitchpole in a 60-knot squall, and slamming to weather across the Atlantic. "It's the violent upwind—not downwind—sailing that destroys a boat," maintains Morrelli. He also taped a laser to the cockpit sole pointed at a bulkhead 90' away. By measuring the light's arc, M&M could "reverse engineer"—work backwards to calculate—the loads required to generate those magnitudes. Load cells in the rig delivered no maximum-load surprises, but M&M found the loads' cyclic nature "shocking." Bar-graph readouts on a laptop showed 50,000 lbs of headstay tension falling to zero

QUICK RELEASE BIMINI TOP HINGE



Unlike traditional bimini top fittings, this hinge's quick release feature allows the owner to easily remove or install the top without having to keep track of screws and pins. The hinge snaps into the base and stays attached to the bimini top when the two are separated. The base mounts directly onto the surface of the boat, which means no cutouts are necessary for installation. It can be mounted on either a horizontal or vertical surface. It swivels 360° and is constructed entirely of 316 stainless steel for a long life in both fresh and salt water.

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and climbing back to 50,000 within a second. "We never figured when the boat pounds that the rigging would go completely slack. It gave us a graphic image of the boat as a living structure," says Morrelli.

M&M are confident they can safely carve out another 10% to 20% of the weight in future boats. "We haven't really fatigued a raceboat yet," claims Morrelli. "Structures like the main beam are deflection critical; by the time they're engineered stiff enough, they're likely to have a factor of safety of up to five. In many cases, if we can determine the loads, that factor can be reduced to 1.5. That's still a pretty-fat margin, and when applied to a 200-sq-ft (18.58 sq m) panel, it could save 500 lbs. Measuring loads, bringing them home, and re-analyzing them to build lighter, faster, and stronger products is an exciting part of the future. Without the testing, without a full feedback loop, you couldn't do it. Without laptops and FEA you couldn't do it."

M&M have also discovered that "stress concentrations between fittings and attachments always bite us in the ass." Morrelli notes, so increasingly M&M is replacing metal chainplates and rivets with line or fiber, as in the old square-riggers; the firm now employs Herreshoff-style strapping to place high-modulus fibers in tension. "Everything I think about now is strapping," Morrelli says. M&M sockets beams on decks and straps them with unidirectional glass or carbon to bulkheads to eliminate placing fibers or fasteners in shear. On *PlayStation*, the axle of an aluminum sheave was strapped with carbon to reduce the weight of a masthead reacher block by 2 lbs 150'(45.7m) in the air. "You can't measure it on a VPP, but we know that lightening up each part of the boat just a little bit matters." They're considering replacing *PlayStation's* headstay wire with Kevlar, which would save another 250 lbs. "We could probably take an additional 600 lbs out of her rig if we switched entirely to rigging made of PBO [phenylene benzobisoxazole] and Kevlar fibers," says Morrelli, "but PBO is the scariest material out there because it's half the weight of Kevlar! We just weren't that confident to go around the world on PBO." At least not yet. They did employ Kevlar shrouds and stayed *PlayStation's* foremost beam with fully molded carbon strapping instead of the usual wire terminal, a concept that could eventually replace conventional rigging entirely.

Gino Morrelli's first foray into powerboats was in 1989, when he was commissioned by adventurer Steve Schidler to design a fuel-efficient multihull. The result was the 40' (12.2m) *Yanmar Endeavour*—a trimaran using stock beach-cat hulls for outriggers and twin 27-hp Yanmar diesel outboards for power. *Endeavour* was capable of 12 knots and 2,700 miles before refueling. She averaged nearly 9 knots while consuming just a gallon per 4.8 nautical miles on a daring passage from San Francisco to Australia via Hawaii.

A few years later, Schidler mounted an attempt to circumnavigate the globe in less than 80 days. For this, M&M lengthened *Endeavour's*, stern,

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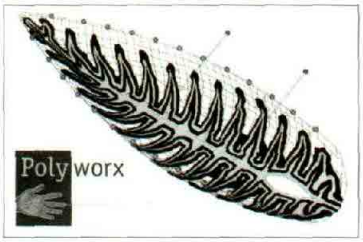

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COURTESY MORRELLI & MELVIN

In 1989, adventurer Steve Schidler asked Gino Morrelli to design a fuel-efficient long-range powerboat. Morrelli responded with a 40' (12.2m) trimaran fitted with twin outboard Yanmar diesels, which Schidler drove from California to Australia by way of Hawaii. The boat averaged nearly 9 knots while consuming 1 gallon of fuel per 4.8 nautical miles.

and added a bulbous bow, a 230-hp Yanmar inboard engine, and new floats that were hydraulically articulated; the boat's operators could now raise the weather float to completely clear waves. The resulting 60'(18.3m) *Revolution* was capable of 27 knots and could make ports 2,000 miles apart. Multiple fuel tanks also allowed the crew to pump weight forward when going upwind to keep the nose down, and amidships to aft downwind. Unfortunately, Schidler's *Revolution* ran aground on an unmarked ledge off the coast of Belize, and was given up for salvage. Morrelli points out that even at 20 knots, the narrow torsos of multihulls won't plane, but they offer high efficiency and smooth motion. He also says, "For a round-the-world attempt, a proa or trimaran makes a lot of sense. All you need is something to keep 'the bicycle' from falling over. The tri is a good idea for pure efficiency, but if you're willing to back off only seven or eight percent, the cat is a lot more practical." And so, in the early 1990s, powercat clients began knocking at M&M's door.

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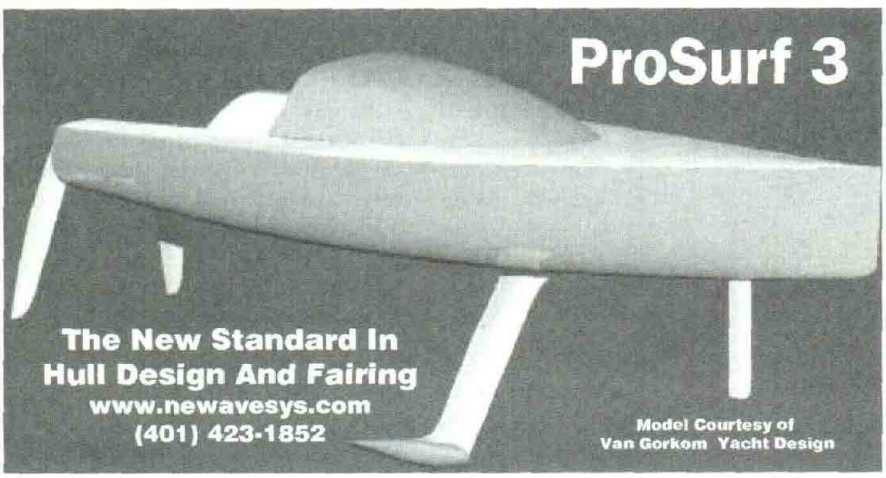

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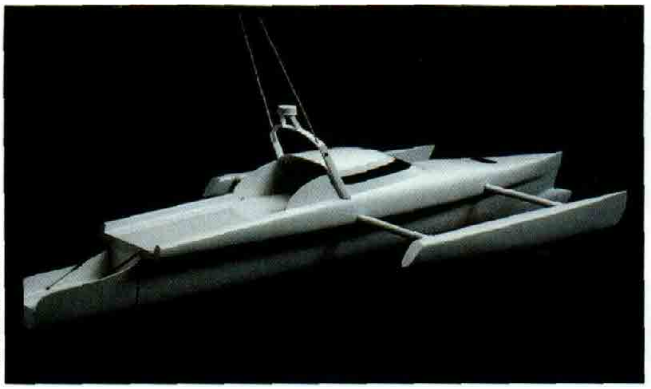

MORRELLI & MELVIN

WERNER KRUTEIN

A few years later, Schidler returned to what was now Morrelli & Melvin and commissioned a design for circling the globe in less than 80 days. M&M drew a 60' (18.3m) tri with a bulbous bow, a 230-hp inboard Yanmar diesel engine, and hydraulically articulated floats (left). The as-built version is shown at right. Schidler's circumnavigation came to grief off Belize, where the boat struck an unmarked ledge and had to be abandoned.

but both power and sail operate in the same sea states." Pete Melvin had designed and built a 20'(6m) prototype for personal use. which M&M have used many times over the years for testing new concepts. This boat is currently a test platform for analyzing the effects of hydrofoils on a powercat hullform.

Today, powercats in general and commercial applications in particular constitute two-thirds of M&M's business. The partners' conduct with clients may be as responsible for their success as their design skills. "We take the time to get to know clients, to understand their businesses, their priorities. We don't want to sell them something because we *think* we understand them, and we don't try to pigeonhole them into something inappropriate. The money is not always at the top of the list," says Morrelli. M&M's hands-on building experience also helps the partners understand and prioritize options. Says Morrelli, "Within an hour of Los Angeles you can buy almost any type of exotic-material and find someone who can weld it or build with it, but we very seldom get a Steve Fossett [owner of *PlayStation]*. How to give clients the best value rules most of our clay-in

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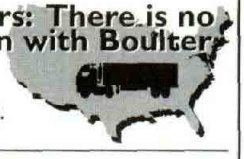

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MORRELLI & MELVIN

The bulk of M&M's business these days is in powercats, particularly those for commercial markets, a good example being this 51' (15.5m) fast ferry for the Lake Chelan (Washington) Boat Co. Twin Caterpillar 3406E diesels turning custom surface drives move 49 passengers at 50 mph.

and clay-out decision-making. We can tell them how *not* to spend money; or, like shifting materials from cool spots to hot spots, where it *would be* smart to spend."

M&M avoid complicated hull shapes such as upside-down hells, even if those retain narrow waterlines while boosting interior volume. Pete Melvin: "In our commercial work, we use shapes without complex curves so that they are developable and can be built from aluminum or fiberglass. A developable shape is much easier to make in glass because the hull can be built in a female mold constructed without a plug, or with prefabricated flat panels. M&M's signature displacement hull shape is an evolutionary product: it combines excellent performance and seakeeping with a low-wake, at a comparatively low cost. That combination is one of the main reasons we've been successful in the commercial boat market."

Morrelli & Melvin are starting to explore the commercial fishing market, but that and the recreational power-multihull market have yet to really take off. Meanwhile, their commercial day-charter clients multiply. "Operators who own circa-1960 PT-style boats that are now rot monsters and cost more to maintain than what they make, are coming to multihulls," notes Morrelli. "Unless there are width restrictions, these customers are attracted to minimal rolling at anchor, a big footprint that gives each passenger lots of room, a smooth ride, and a little bit of fuel economy, though it's less than claimed—probably 40% or less in the real world at various payloads. Our powercats are benign, like driving buses. That's what operators want," adds Melvin. M&M has produced a high-speed passenger cat with split-V tunnel hulls, but most of

Continues on page 102

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The fine-entry hulls slice through the water effortlessly, with little of the rolling motion so prevalent in displacement monohulls. A powercats rolling motion can he tuned to specific sea conditions by varying the spacing between the hulls.

The hull resistance of a displacement monohull rises sharply at a speed-to-length ratio of about 1.3 due to the hull trying to climb over its own bow wave. By comparison, the sharp and narrow hulls of a displacement powercat penetrate the bow wave with minimal drag increase. There are several successful variations of displacement powercat shapes in use today; the choice of specific-shape depends on materials type and manufacturability, and to a lesser extent on actual performance.

Planing Catamarans

Planing powercats have wider hulls for a given length than do displacement powercats and are therefore more tolerant of added payload. The

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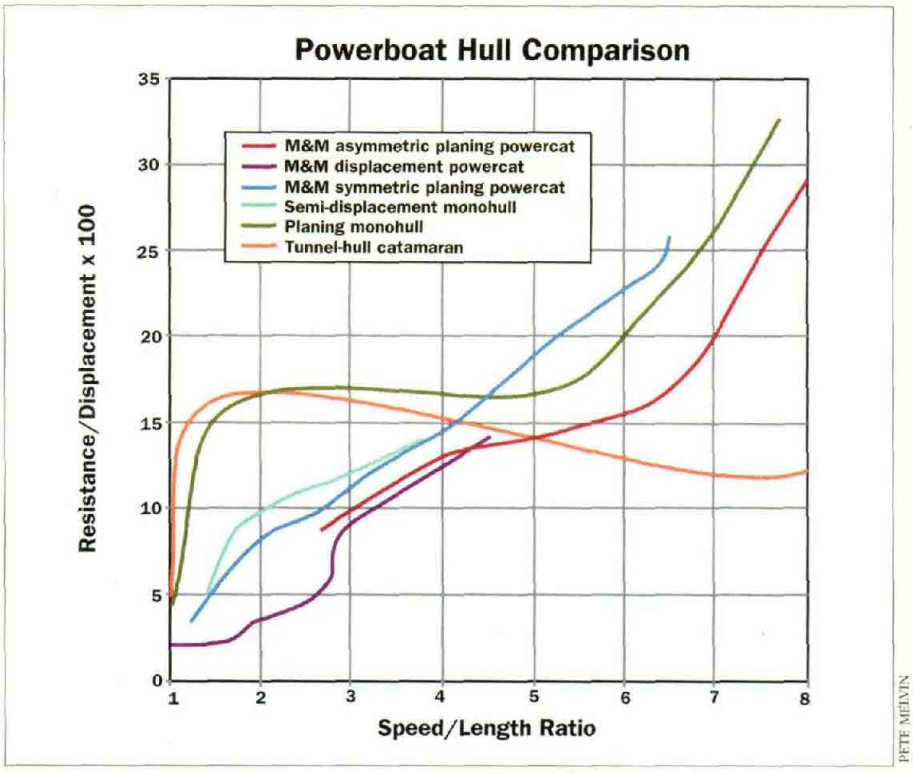

In their design practice, Gino Morrelli and Pete Melvin have made it a point to study the competition by category, in both detailed and general comparisons. This graph is one of the latter, and examines performance differences by powerboat hull type.

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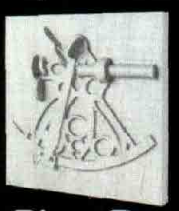

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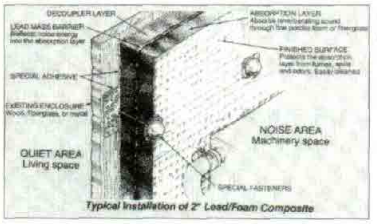

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their boats are fairly conventional, with displacement hulls maintaining length-to-beam ratios of 12 to 14 and geared to go 20 to 25 knots.

Diversity has served M&M well. "We're getting to be known for being able to find at least reasonable solutions to odd problems," says Morrelli. "We do so many weird boats, there's never a dull moment." Indeed. When the producers of the television program "Murder She Wrote" were looking for a futuristic boat model to fit an episode in which a boat designer is killed by his client, they turned to M&M, whose designs have also performed for commercials and appeared in the remake of the movie *The Thomas Crown Affair,* which showed two M&M F40s in a spectacular sailing sequence.

M&M's expanded portfolio has given them a unique view of the future. Consider, for example, their 13'(4m) rotomolded Hobie Wave, winner of an IMTEC innovation award. (IMTEC was the acronym for an industry trade show, since discontinued, held annually in Chicago and sponsored by the National Marine Manufacturers Association.) "We think another two or three feet of boat length there is possible. So is a little powercat that can sell for less than $4,000." says Morrelli. On the downside, the partners envision a steady decline in the cruising sailboat market as buyers increasingly turn to powerboats, and sailing multihulls continue to face the practical challenges of cost due to so much buildable surface area, plus extreme beam, which limits slip space and maneuvering in harbor. Still believing that multihulls make superior cruising craft, M&M persevere with custom and semi-custom designs. Morrelli thinks luxury megacats may eventually become one of the three most promising areas of development. Others include power cats in the 30' to 50'(9m to 15.2m) range, because those boats aren't too wide for a slip, and they offer numerous advantages. Morrelli and Melvin also envision great possibilities in trawler-style catamarans, a category that has been growing way out of proportion to the rest of the market in monohulls.

No doubt we'll see more spectacular racing sailboats from M&M, too, as the firm pushes the limits of engineering and materials. Morrelli envisions sailboats flying on hydrofoils, and the partners have been working with an Italian foil designer to install partially lifting foils on a lake racer. "Eventually, with continued developments in rigs and construction, people will be averaging 35 or 36 instead of 25 and 26," he says. In the shorter run. *PlayStation* remains "unfinished business. I'd like to see it break the Jules Verne [record for a circumnavigation] and recapture the 24-hour record. There's still a lot of potential that we haven't tapped." PBB

About the Author: *A multihull sailor with many offshore passages to his credit, Steve Callahan has designed and built a number of these boats. He's, written widely on adventure-racing designs and personalities, and authored a short text on multihull design while working at the Yacht Design Institute 20 years ago.*

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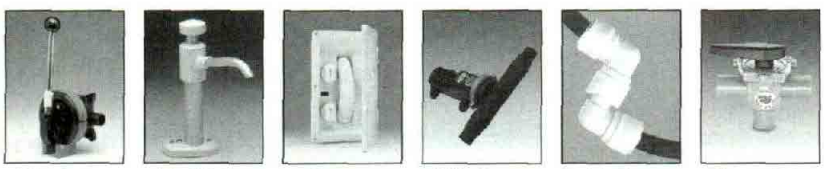

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cushion effect of water and air being squeezed between the hulls greatly softens impact when powering through waves. Planing powercats generally have a smooth transition from displacement speed to planing speed. Because of their narrow form, the hulls of a planing powercat surpass the 1.3 speed-to-length barrier more easily than a planing monohull does. This generic advantage becomes apparent when operating in the speed/length range from 1 to 3, where a planing monohull typically requires huge amounts of horsepower to climb over its bow wave and accelerate to full plane. Operating a monohull at speeds in this transition zone calls for constant throttle modulation and results in poor fuel economy. By contrast, that transition zone is hardly noticeable in a planing powercat, making this type of craft ideal for ease and efficiency of operation across a wide range of speeds.

Symmetric-hull planing powercats offer the smoothest ride and are excellent performers at moderate to high speeds. Asymmetric-hull planing powercats have a harder ride but also less resistance at very high speeds—the reason most offshore racing cats have asymmetric hulls.

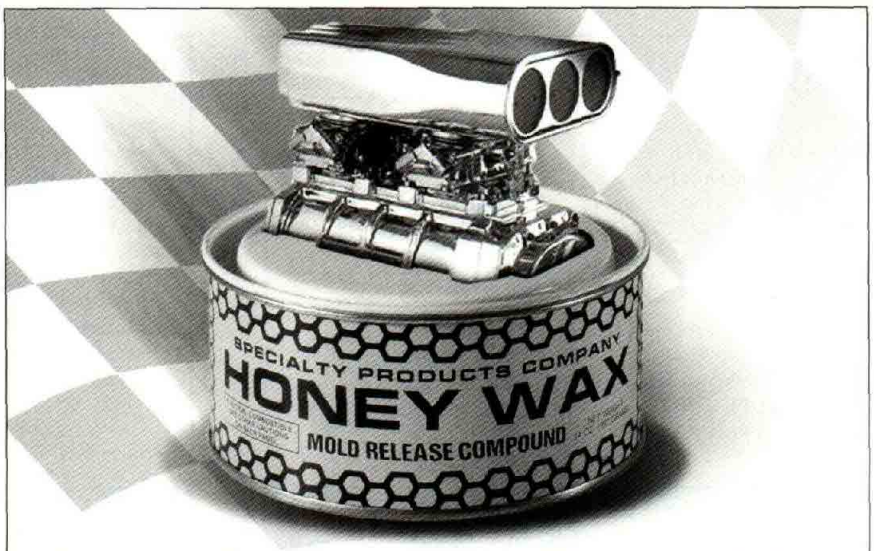
Another, more recent variation is to put a set of transversely oriented hydrofoils between the hulls of a planing powercat. The hydrofoils support about 50% of the weight of the vessel, lifting the hull partially clear of the water but keeping the running gear immersed. This type of hydrofoil arrangement reduces overall resistance by a minimum of about 20%. Poorly designed or overloaded hulls can significantly benefit from the addition of foils.

A smooth ride is the greatest advantage a planing powercat has over a planing monohull. In general, boaters are skeptical until they take their first ride in a planing powercat in choppy conditions. One convert, Larry Diener. writes: "Full flight, high enough and stupid enough to get nose down, produced a very gentle landing with little deceleration."

If lots of deck area is what you want, then a powercat is what you need. Typically, powercats have 20% to 40% more deck area than the same size monohull. Planing powercats are usually decked from bow to stern and have lower cockpit soles than displacement powercats, making them a good choice for smaller fishing and dive boats where you need to be close to the water.

For those who must see to believe, a powercat demonstration may be the only way to appreciate the special characteristics of these craft. In our view, a powercat's stability, ride, fuel efficiency, and roominess are the qualities that go a long way toward making people glad to be on the water. *—Pete Melvin*

[This essay was adapted and updated from a presentation Pete Melvin made at an IBEX seminar in 1997—Ed.]



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