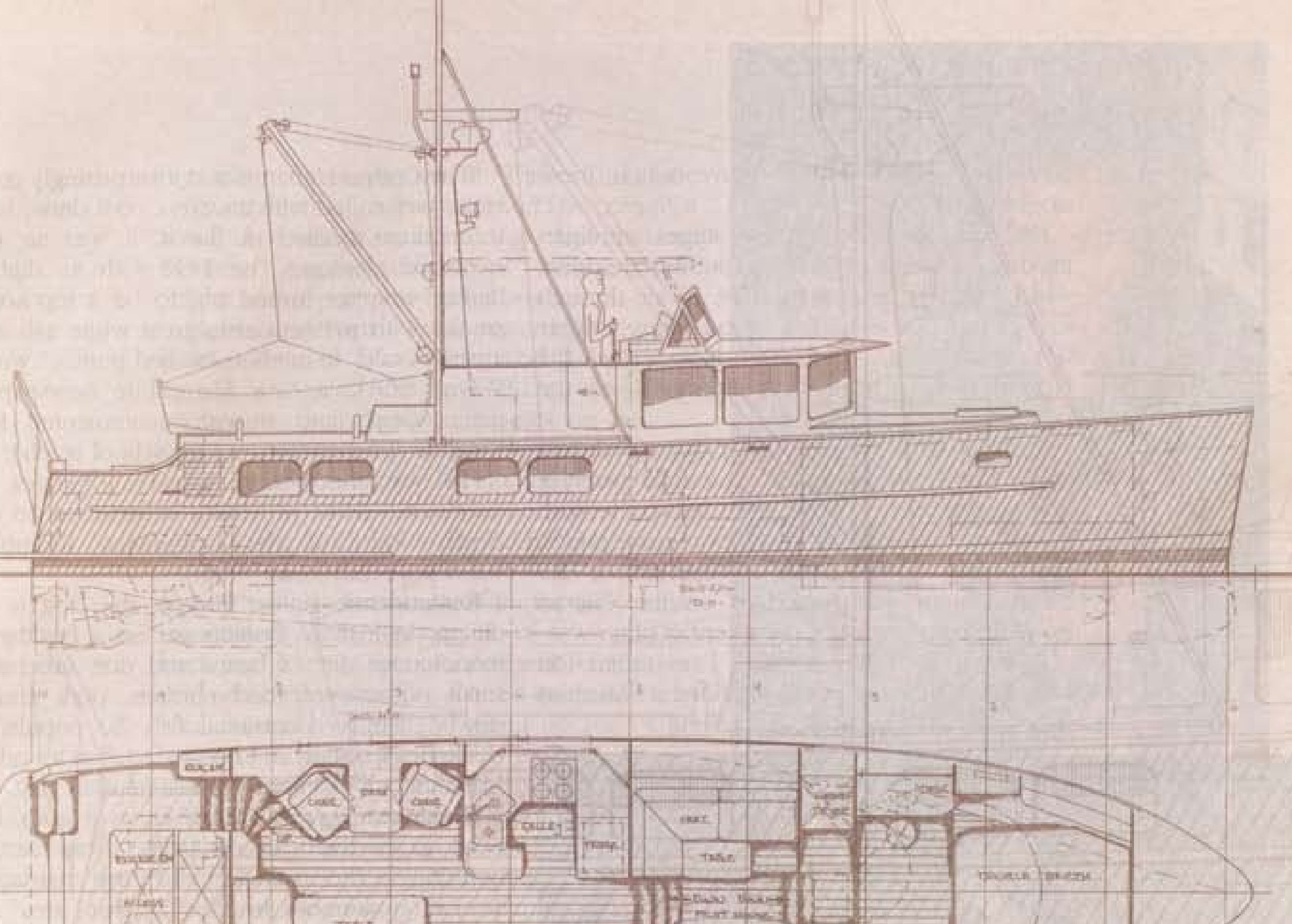


Passagemaker Lite

by Tad Roberts

COMMON WISDOM HAS IT THAT PASSAGEMAKERS CAN GO far, but slowly. And that coastal cruisers can go faster, but not far. We are seeing some change in this thinking with the success of "trawler cats," lighter displacement vessels capable of long offshore voyages at higher speeds. However, the high, wide, somewhat spacey looking catamarans, although useful in comparing performance possibilities, can hold little attraction for the traditional sailor.

Conventional trawler yachts also are increasingly being driven above pure displacement speeds, but the gain of 1 or 2 knots is only possible with huge engines and oceans of fuel.

I believe there is an alternative, a monohull that can achieve long range with good economy, speed and traditional good looks. I call this new type Passagemaker Lite.

When we think of serious cruising in a motoryacht, the vessel that immediately springs to mind is one of the currently available trawler yachts. Boats such as the Krogen 42 and Nordhavn 46 are examples of the type Robert Beebe termed "passagemakers."

For their length, these boats are high, wide and heavy. This form is an imitation of the commercial trawler, with all its connotations of rugged seaworthiness. But commercial trawlers are designed with a very different criterion in mind: hauling fish. The short, wide hulls are limited to what most of us consider very slow speeds, actual over-the-bottom cruising speeds of about 6.5 knots. So no matter what the fuel consumption, a principal objection to conventional trawler yachts must be wasted time.

The problem of how to cruise efficiently in a displacement hull, or farther at faster speeds, is how to increase the efficiency of a displacement hull. One approach is to make it longer for a given weight, or decrease displacement for a given length. The availability and reliability of cored fiberglass, aluminum or wood composite construction enables the creation of vessels with stiffer, lighter structures.

ILLUSTRATION BY TR DESIGN

We also have modern lightweight diesel engines to aid in this dieting program. A lightweight structure means higher speeds from less power, and less power required means less fuel burned.

Passagemaker Lite can thus carry less fuel to achieve her long range while traveling at a higher speed. These higher speeds require another change, that of hull form. My Passagemaker Lite hull is of the "high-speed displacement" form, a shape closer to a naval frigate than a fishing vessel. She has a long waterline, relatively narrow beam and fine entry. In the manner of a frigate, there is some rise to her sections aft, but there is still deep immersion of the hull at the transom. Displacement is spread out along the hull to counter trimming tendencies. This shape also is steeped in history and romance.

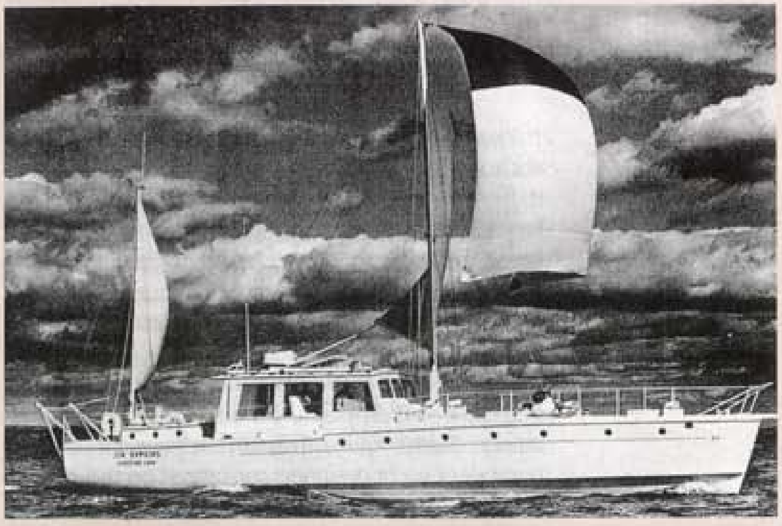
Boats Of The Past Were Fast

Let's look at the history of lighter weight fast boats that still have serious cruising range. In the early part of the last century, motoryachts began as refinements of fashionable and elegant sailing yachts. These became the rumrunners and fast commuters of the roaring '20s.

Engines of the day were of fairly limited power, and so efficiency was achieved with long, lean hull forms. *Marlin*, built in 1930 for Edsel Ford to a design by Walter MacInnis, is a fine example of this type. She is 51 feet 6 inches by 12 feet 6 inches with 3-foot draft and powered by twin 245hp Sterling gas engines. Her top speed was 24.5 knots at 1500 rpm. Mr. MacInnis was well known as a designer of rumrunners, euphemistically referred to on their drawings as "cargo boats."

These lighter displacement yachts of a more refined style were, to quote Francis Herreshoff, "better suited to the conveyance of ladies and gentlemen than dead fish." Their hulls were drawn to derive excellent performance from a limited amount of power; current practice is to start with a given accommodation plan and wrap a hull around it, then try to improve performance with various bulbs or fins.

Long-distance cruising in powerboats began in 1937 when French yachtsman Martin Marie crossed the Atlantic alone in *Arielle*. There had been several stunt voyages previously, but this was the first real ocean cruise in a powerboat. Martin Marie was a marine painter, and he wished to spend time with his subject. *Arielle* was 42 feet 6 inches long and of moderate displacement and proportion, certainly no massive heavyweight. Fitted with a 75hp Baudoin diesel and 1,500 gallons of fuel, she reportedly cruised from New York to Le Havre, France, in 19 days. This calculates out to the respectable average speed of 6.7 knots for the distance of 3,063 miles.



HISTORIC PHOTOS PROVIDED BY TAD ROBERTS

Facing page: The author's Passagemaker Lite 46 defines the long, lean hull form, while his larger PL 56 provides even more accommodations.

Top: *Jim Hawkins* proved an able, efficient passagemaker.

Middle: *Marlin* running at speed. Images of rumrunning, Wallace Beery and Marlene Dietrich. Ah, the good old days.

Bottom: *Woodpecker* is far more graceful than her name implies, and shows the design styling eye of Laurent Giles.

The voyage of *Arielle* and Martin Marie passed without incident, the engine ran smoothly and they met no dramatic weather, causing little fanfare. Ocean cruising under power was obviously not heroic and perhaps even a bit boring, and there was little interest from the yachting community.

During the Second World War military personnel were stationed in hundreds of exotic ports around the world. They saw places such as the Solomon Islands, the Philippines, Australia and the Mediterranean. Many vowed to return in peacetime, and a number of yacht designers capitalized on this market. After the war, L. Francis Herreshoff published a design for the long distance offshore cruiser, Marco Polo. Long, lean and light, she was designed for efficiency under power, with sails for steadying, additional drive and get-home power. The three-masted rig provided adequate sail area down low, with lots of combinations available depending on wind strength and velocity. No sail was too large for the single watch keeper Herreshoff envisioned. Her designer intended Marco Polo to be driven

BILL PARLATORE

The popular Nordhavn 46 is among the most successful passagemakers of all time. Many have circumnavigated, and the 46-footers can be found cruising just about anywhere in the world.

round the clock at 10 knots, a tremendous speed at a time when sailing ocean cruisers averaged 100 miles per day.

She is 55 by 10 feet, with a designed displacement of 42,500 pounds. On a 49-foot waterline this is a displacement/length ratio of 161. She has an outside ballast keel of 14,600 pounds—34 percent of her displacement—reflecting the fact that she carries 812 square feet of sail and is designed as a 50/50 motorsailer.

The Marco Polo design influenced a number of designers, Robert P. Beebe being one (see *Voyaging Under Power*, published by International Marine). After a 1957 voyage from New York to the Bahamas in a Marco Polo, Mr. Beebe wrote in *Rudder* magazine, "The hull is terrific. The action of the boat in a seaway was a joy to behold."

An amateur designer similarly influenced was Avard E. Fuller, who, working with builder Bob Derecktor, developed a series of light displacement ocean cruisers. Launched in 1969, the Jim Hawkins is an example of Fuller's work. She is 61 by 13 feet, displacing 47,500 pounds fully loaded. With a 58-foot-4-inch LWL, her displacement/length ratio is 107. Two Volvo Penta MD29 engines develop 64hp each and push her at 9.5 knots in smooth water, burning 4 gallons of fuel per hour. At 7.5 knots and a speed/length ratio of .98, her engines are running at 1850 rpm and burning 2 gph.

By way of comparison the Nordhavn 46, which is of similar displacement with a waterline 20 feet shorter and a displacement/length ratio of 383, burns another gallon an hour for the same 7.5 knots. Therefore, fuel consumption increases 50 percent due solely to hull form.

It would take tremendous power for the shorter, wider vessel to reach 9.5 knots. We could redesign the trawler hull as a semi-displacement vessel and install more power to manage the 9.5 knots. Then it would take about 160hp to push our modified vessel to a speed/length ratio of 1.53. With this much power she would burn 9.6 gph, two-and-a-half times that burned by Jim Hawkins.

Are Marco Polo and Jim Hawkins anomalies that bring nothing to the development of Passagemaker Lite? I don't believe so; there is a long line of similar boats produced by various designers over the years.

In 1948 British designer Laurent Giles produced the lovely *Woodpecker*, with a 70-foot LOA by 14-foot-1-inch beam and displacement/length ratio of 90. In 1955 William Garden created *Little Goose*, 60 by 15 feet and running at 9 knots with 120hp. Tom Fexas brought us the Midnight Lace series in the late 1970s, 44 by 11 feet and 52 by 13 feet. Designer Penn Edmonds has recently created *Fayerweather*, a 60-by-11.5-foot boat that weighs 25,000 pounds. In every case the designers were chasing comfortable and seaworthy speed, achieved with boats of small midsection driven by moderate-sized engines. As a side product they also produced some very handsome boats.

A smaller version of this type is my Yellow Cedar design, 38 by 10 feet and displacing 15,000 pounds, she has a displacement/length ratio of 123. Powered by a 51hp Yanmar diesel, she cruises at 7.5 knots burning 1.25 gph. That's a cruising range of 540 miles on 90 percent of her 100-gallon fuel capacity.

If we have long known the efficiencies of long, light hulls, with a tradition of fast and beautiful boats by famous designers, why are there so few boats like Jim Hawkins available?

Something New

Let's consider some of the objections to Passagemaker Lite. First, it is believed that low, narrow boats are wet and roll more than wider ones.

A second objection is that in terms of accommodations, a narrow boat will have less living space than a wider vessel. A third comment questions whether a lighter vessel can really be as safe as a wide, fat boat.

In drawing Passagemaker Lite I have created a hull with maximum waterline length for a number of reasons. The long waterline reduces wave making, a key component in resistance. This also means that the hull's entrance can be finer, again reducing resistance. Finally, the long waterline provides more useable interior space than a hull of similar length with long overhangs.

This brings us to the question of freeboard. The Passagemaker Lite hull has moderate freeboard forward. Why? Higher freeboard means increased weight and windage. Because of the short overhang, Passagemaker Lite's bow starts to lift as soon as it encounters a wave, thus she can stay dry even with lower freeboard. This bow is similar to that of modern high performance sailboats, and an important factor in its behavior is keeping weights as far aft as possible. The "squirrel cheek" type bulbous bow also provides reserve buoyancy to lift the bow.

A full-length spray rail above the waterline is another hull feature that allows fine waterlines with increased buoyancy up high and keeps the deck drier at speed.

The best way to recognize Passagemaker Lite is beam/length ratio. With a beam of 15.42 feet and overall length of 45.75 feet, the Nordhavn 46 has a beam/length ratio of .337. That of the Krogen 42 is .35. This is typical of most modern trawler yachts. Marco Polo's beam/length ratio is .18 and that of Jim Hawkins is .21. These are a

The Memory 38 is based on Roberts' Yellow Cedar design. This thoroughly modern boat does look like it came from the last century. The narrow hull is efficient yet still offers good accommodations, as can be seen in the photos, which is a credit to both designer and builder.

PHOTOS PROVIDED BY MEMORY YACHTS

bit extreme for my taste; my newer designs have more beam and thus more interior space. Yellow Cedar has a beam/length ratio of .26, while my Passagemaker Lite 56 is .24 and my PL 46 is .26. I think we can say that typical modern trawlers have a beam/length of over .32, while Passagemaker Lite will be between .2 and .26.

Because Passagemaker Lite is of as low a profile as I can manage, her vertical center of gravity will be lower than that of the high and wide trawlers. As her hull is only large enough

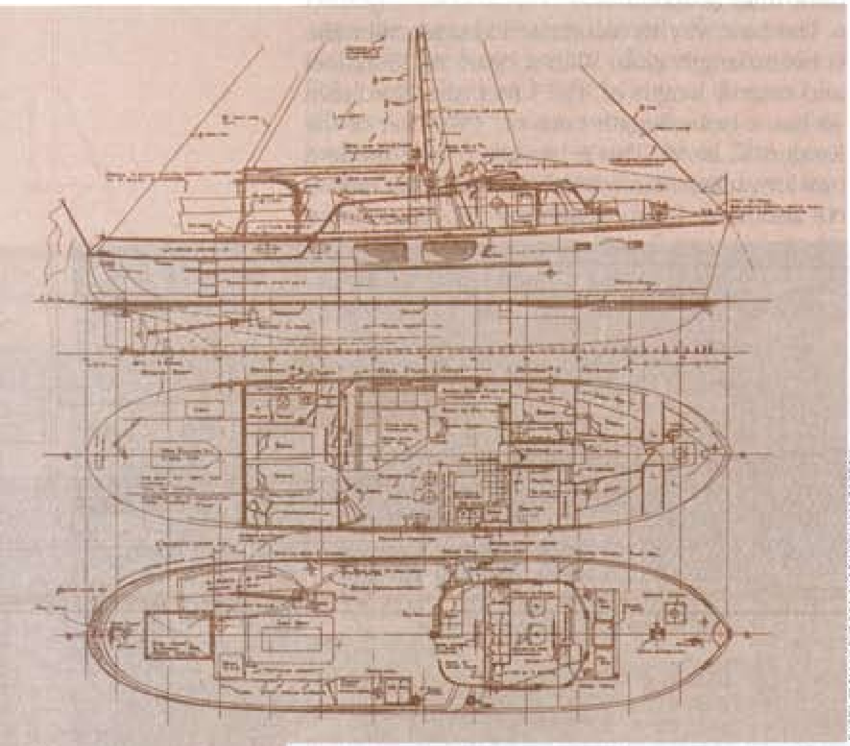


PHOTO FROM *YACHT DESIGNS* BY WILLIAM GARDEN

Drawing details of Garden's *Little Goose*. At 63 feet, the yacht is one of Garden's favorites, named after Little Goose Creek in Wyoming. It was inspired by the working fishing boats of the era.

to carry her own weight, there is no need to weigh her down in the water with a lot of ballast. But we do need a small amount to ensure quick recovery from a high angle roll. So the PL 46 will have 2,500 to 3,000 pounds of lead in her keel, and the PL 56 will carry about 4,500 pounds.

Stable Platform?

As I have mentioned, a major concern with both heavy and light displacement passagemakers is stability. Again, let's look at displacement. A vessel's displacement is equal to the total weight of her structure, ballast and payload. The structural weight is dependent on its size; the smaller the boat, the lighter the weight. Less ballast can be made more effective by using lightweight cored structures in decks and cabin tops, and also by minimizing the height of those structures above the waterline.

If a designer can minimize this upper weight, it will reduce the boat's tendency to continue rolling. That is, it reduces roll-inertia, the tendency for a mass to keep moving once in motion.

Also, the lower and more centered the weights are, the less energy required to damp out rolling once it starts. The idea that high, wide and heavy boats are stable can be a falsehood, though they certainly feel stable at the dock. Real stability is something different, and a narrow hull, if low enough, can have more stability than a wide boat.

Stability can be addressed in two areas, initial stability and ultimate stability. Initial stability, or "low angle" stability, is dependent on hull form; wide hulls have high initial stability. This is nice at the dock on a calm day, but once the boat starts moving, motion can be quick and jerky. In the case of wide, flat hulls, the center of buoyancy shifts outboard very quickly as the vessel heels. With a deeper, narrower shape the shift happens more slowly, so rolling can be deeper and more easily started, but it is slower and more predictable.

Ultimate stability is dependent on beam and height of the center of gravity. A narrower boat has higher ultimate stability, and a boat with lower superstructure has a lower vertical center of gravity. Thus the lower, narrower boat has more reserve stability at high angles of heel. Rolling can be much reduced in the modern passagemaker, of wide or narrow form, with active stabilizers, flopperstoppers, gyro stabilizers or flume tanks. But in Passagemaker Lite this translates into smaller stabilizers to install or lighter flopperstoppers to handle.

Accommodations Need Volume

Internal volume is another question. Cubic numbers can be useful in comparing vessels of differing dimensions. This is simply length times beam times depth. Length is LOA plus LWL divided by 2, and depth is height from main deck to fairbody.

Again, using the Nordhavn 46 as an example of a popular modern passagemaker, it has a cubic number of 42.04 x 15.5 x 8 = 5,200. The volume of the Jim Hawkins design is 59.66 x 13 x 7.5 = 5,800, about 11 percent more. The Nordhavn has more interior above the main deck level and therefore achieves similar volume, but this comes at the cost of a higher center of gravity.

The cubic number of the Passagemaker Lite 56 is about 4,900, 94 percent of the Nordhavn's. She will have somewhat less space because the only double decking will be where the flybridge/boat deck extends over the main cabin.

I minimize the narrow feeling in my Passagemaker Lite designs by utilizing the full hull width as much as possible, with the raised topsides and flush deck. Raised topsides also add to the

My theory is that we can cruise the world's oceans without having to imitate heavy displacement commercial vessels.

boat's ultimate stability range, creating a safer vessel than the usual trawler with its low side decks. My designs achieve their light weight by being narrower and lower in profile. Thus they are of smaller section than wider, higher vessels, but because of their length, they still provide reasonable interior space. And less tankage means more interior space for accommodation.

Can Passagemaker Lite be built to this seeming optimistic weight target? I believe so, but it will take a slight shift in mind set to achieve it. In the current crop of wide, heavy trawler yachts, heavy is good. And this is true if you are trying to weigh down a huge hull designed to carry a load of fish, or if one is trying to slow the motion of a hull that is too wide and too high.

By contrast, the Passagemaker Lite mind set goes in the opposite direction; how we can make it stronger and lighter are key design criteria. These are the same factors driving the creation of modern trawler cats and ultra-light sailing cruisers, such as Steve Dashew's Deerfoot type. The concept is that we can reduce weight everywhere. Instead of carrying all 29 hard-bound volumes of the *Encyclopedia Britannica*, for instance, take the CD version.

Materials Matter

Avard Fuller managed to produce a lightweight voyager using aluminum and keeping the interior arrangement simple. Aluminum is certainly a good option for the construction of Passagemaker Lite, and it is the first choice for those concerned with possible collisions offshore.

She could be built even lighter by going to a composite-foam-cored glass structure. Then every part of the boat, hull, deck, house, stringers and bulkheads would be built of fiberglass skins over a foam core.

Using this all-bonded structure, we can add the interior using the same materials; cabin sole, lockers, shelves, counters and berths all can be bonded to the hull and become part of the structure. This increases stiffness without adding any extra parts. Once bonded in, these glass faces can be filled and painted or veneered with wood. Fabric covering for bulkheads and overhead also is stylish and lightweight. Light painted surfaces, small amounts of wood trim and colorful upholstery create a comfortable and livable interior that's lightweight as well.

I have sketched Passagemaker Lite designs in lengths from 38 to 72 feet, but for this article I refer to the PL 56 and 46.

Common features include a forward pilothouse with upper outside bridge aft over the main living area. The main living area is low in the boat; the cabin sole is approximately a foot below the waterline. This minimizes motion, a welcome feature for the cook trying to work at sea.

Another common feature is the aft engine room. There is no living space around or on top of the engines. The main machinery is completely isolated by a full height watertight bulkhead. Fire, flood, noise, heat and vibration all are contained separate from the living quarters. Video equipment and alarm systems will be used for continuous monitoring of the machinery. Access as drawn is down a ladder from the afterdeck, but a watertight door/window could be installed from the main saloon to the engine space.

Both interior arrangements include a single head and sleeping cabins forward. The single head is due to personal preference for one large room rather than two tiny ones. These accommodations are intended for a couple to live aboard long term, with occasional guest and crew aboard for passages.

On such passages, the off-watch will sleep on the seat in the wheelhouse or in the saloon aft. During coastal cruising or at anchor, the forward owner's cabin provides great privacy from guests sleeping in the main saloon.

The deck layouts are similar, only differing in the size of particular areas. Boarding is from the stern, via a swim step and up a few stairs to the after well deck. Here there is seating on the engine room trunk, which opens to provide full access to the engine area. One can change out or rebuild an engine or generator without disturbing the liveaboards.

From the well deck there are stairs up on starboard to the boat deck and down on port into the saloon. The boat deck stretches from rail to rail, with room to store a good-sized hard bottom inflatable. At the forward end is the mast with boom to handle the dinghy, and stabilizer poles port and starboard.

Forward of the boat storage area is the bridge deck. Here are outside controls, seating and outside dining area. This is sheltered from the elements by a half-height windshield forward and a canvas soft top overhead. The enclosing half walls have sliding gates port and starboard, and access to the wheelhouse is down a sliding hatch to starboard.

What's important about this setup is that the helmsperson is only a couple of steps away from line handling when docking the boat.

Forward of the wheel house are hatches to let in light and ventilate the sleeping cabins. All the way forward is another well deck, this one for safety during anchor handling duties. This will be secure in all weather; 36-inch life rails on top of 18-inch high bulwarks mean rails about 4 feet high in this area. It's not likely anyone will be pitched off while trying to anchor the boat!

Moving the machinery aft shortens shaft runs and minimizes noise and vibration in the living areas of the boat. It also frees up space under the wheelhouse and saloon for tankage centered over the center of flotation. This means trim changes little as fuel is burned and water consumed. Fuel and water loads are the largest single weight aboard these boats, and so centralizing and keeping them low again reduces pitching and rolling moments.

Propulsion Choice

This brings us to the engines. Why twin engines? Unquestionably, a larger single engine with a single large-diameter propeller would be more efficient. But a large single prop would mean more draft, even with a propeller pocket. These two are in pockets behind substantial skegs, which will protect them and hold the ship upright when she takes the ground.

In looking at moderate-sized serious offshore yachts, I note two, three or even four engines aboard. Most owners of single-engine vessels opt for the security of a wing engine, and they also have a generator or two aboard. I would suggest the two small engines on Passagemaker Lite could serve as redundant propulsion systems and be belted or coupled via PTO to generators. Thus these two (excepting the dinghy's outboard) could be the sole engines aboard. Reducing the weight and cost of systems is part of the Passagemaker Lite diet.

I have chosen a pair of John Deere 4045DFM four-cylinder, naturally aspirated engines for the PL 56. These engines produce a maximum of 75 bhp at 2400 rpm and have ZF 63 IV V-drive reduction gears mounted on them. A reduction of 2.477:1 is a maximum of 970 rpm at the propellers. Exact resistance figures for the PL 56 await tank testing, but I can make some predictions based on the work of Roger F. Compton. His 1986 paper "Resistance of a Series of Semi Planing Transom Stern Hulls," published by SNAME, is the most useful guide to predicting the resistance of this type of hull.

According to Mr. Compton's method, the John Deeres would push the PL 56 to a top speed of just over 11 knots. That's in calm water, with flopperstoppers out of the water. These engines are rated to produce 75hp continuously, 24 hours a day. But we will back off some for long distance cruising.

Let's look at a long distance cruising speed of 10 knots. This would require approximately 88hp total, 44hp from each engine. This is about 2100 rpm on the John Deeres, which will consume 2.6 gph each at this speed. Total fuel capacity for the PL 56 will be 1,100 gallons, let's say 900 useable with 200 in reserve or to run a small generator. The 900 gallons of fuel will take us about 1,700 miles at 10 knots. That's a long cruise coast-wise, but not quite enough to cross an ocean. Dropped back to 1900 rpm the vessel will burn about 3.9 gph total, and the 900 gallons will last 230 hours. At 9.5 knots through the water and 9 over the bottom, our range will now be 2,075 miles. This will get us across the Atlantic but still is short for the West Coast to Hawaii. That crossing will require another speed reduction, to about 8.5 knots over the bottom.

The payoff for lighter displacement and a longer waterline is more speed with the same or less power. The Nordhavn 46 crosses oceans at a speed/length ratio of about 1.2; this is 7.4 knots. For my PL 46 design a speed/length ratio of 1.2 is 8 knots, and for the PL 56 it is 8.8 knots. On a long voyage, the 2,200 nautical miles from Southern California to Hawaii, for instance, this can make a difference of days.

Twenty-two hundred miles at 7.4 knots is 297 hours, while at 8 knots it is 275 hours, and at 8.8 knots it is 250 hours. The PL 56 would take about two days less than the Nordhavn 46 on the same passage.

To obtain greater speed from the short, fat trawlers, builders are going to ever-larger engines. But it is expensive to push hulls with high displacement/length ratios fast. It also is true that as displacement/length ratios drop, speed/length can increase. Short, heavy boats with a displacement/length ratio of 350 will be limited to a speed/length ratio of about 1.4, maximum. Longer, lighter designs can run up to a speed/length ratio of 1.6 and beyond. This is possible with modest power; the PL 56 will achieve 12 knots with a pair of 105hp engines. Twin 150hp engines will push her up over 14 knots.

Making Light Work Of Passagemaking

My theory is that we can cruise the world's oceans without having to imitate heavy displacement commercial vessels.

Instead, we can make relatively fast long-distance passages in yachts designed expressly to combine seaworthiness and beauty, economy and long range with comfortable motion and accommodations.