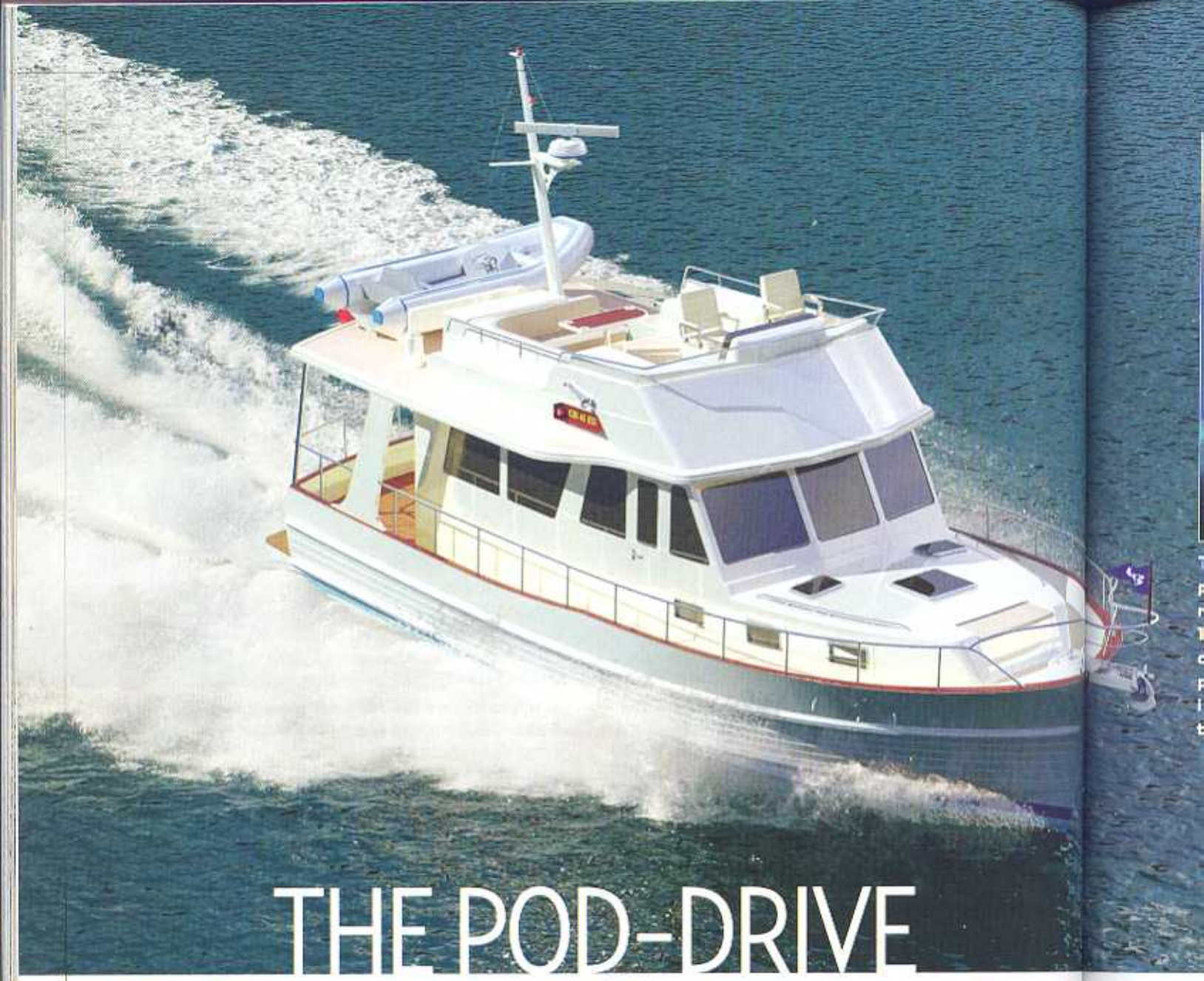

THE POD-DRIVE REVOLUTION

Vectored Thrust Brings Big Benefits to Power Cruisers

By Chuck Husick

THE NEXT MULTI-ENGINE CRUISING boat you buy may have no exposed prop shafts, no struts and no rudders. In addition, you'll likely find something at the helm usually associated with aircraft and computer games: a joystick.

Start the engines and when you are ready to leave the dock, you won't have to touch the throttles or the wheel. Instead, you'll gently deflect the joystick toward the direction in which you want the boat to move, and it will instantly obey your command. To turn around once the vessel is clear of the dock, you'll simply twist the joystick, and the boat will rotate in place. Upon returning, you'll find that docking — even in challenging current and wind conditions — presents few, if any, problems.

And there are other differences. In boats that have been designed (or redesigned) for pod drives, there is more usable

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The new Grand Banks 41 EU cruiser will be powered by a pair of Zeus drives that will reportedly give it a cruising speed of at least 18 knots. At right is a closeup of a single Zeus drive unit with its rear-facing, counter-rotating propellers and integral, trailing trim tab. Below is a pair of Volvo diesels and IPS drives. Note the forward-facing props.

accommodation space below than you would expect (read, bigger staterooms, galleys and/or heads). While underway, you will likely notice that the boat is very quiet, with virtually no exhaust noise or fumes, and a pleasing lack of vibration. Yet another nice surprise awaits when you top off the fuel tanks at the end of a trip: The boat may have consumed 20 percent less diesel than you expected.

All of this "magic" is the result of your having chosen a vessel equipped with a vectored-thrust propulsion system, either a Volvo Penta IPS (Inboard Propulsion System) or a Cummins MerCruiser Zeus Drive system. With either one, you will enjoy a noticeably different cruising experience, one that will begin when you leave the dock and continue until you retie all the mooring lines.

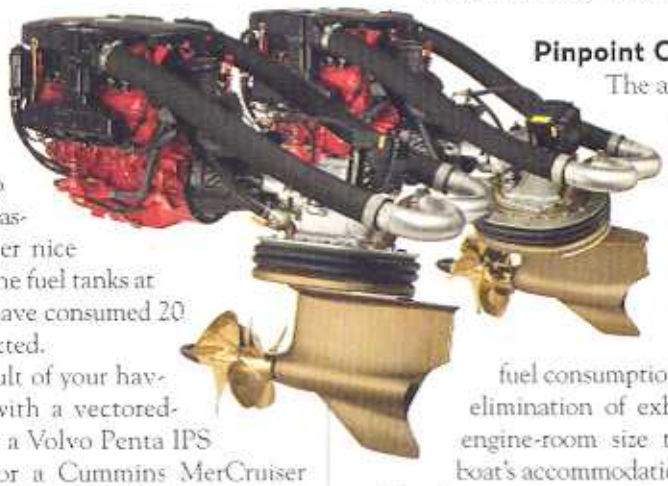
Great Minds Think Alike

The IPS and Zeus propulsion systems are very similar in their most essential features. Both dispense with conventional prop shafts and rudders by delivering the thrust needed to maneuver the boat from steerable propulsion units (pods). Mounted under the hull, just forward of the transom, each one resembles a sterndrive leg, with counter-rotating propellers.

Working through a sophisticated computer, the boat's steering system (both the wheel and the joystick) controls each drive pod independently and — by selecting the direction of thrust for each unit — moves the boat precisely as commanded. Volvo Penta introduced its IPS in the fall of 2004, and Cummins MerCruiser announced the Zeus about 15 months later. Both systems are now having a significant impact on their initial target market: planing-hulled yachts ranging from about 30 to 75 feet in length.

Such boats were chosen for both the IPS and Zeus vectored-thrust systems because they can display attributes of the technology that might not be as impressive in displacement or semi-planing hulls. These include faster acceleration, greater top speeds, a tighter high-speed turning radius and a better sustained cruise speed than possible in an identical planing hull with the same horsepower in a conventional configuration.

The applicability of these drive systems to cruising boats has been further validated by the recent announcement that the new Grand Banks 41 Heritage EU will be powered with a Zeus drive system (see *Power Cruising* November/December 2007, page 65). Moreover, two well-known express-cruiser builders, Legacy Yachts and Sabre Yachts, will produce pod-drive versions of their respective 42-footers in 2008.



Pinpoint Control

The advantages of vectored thrust for cruising boats begins with the remarkable joystick control, which provides unsurpassed low and even "zero-speed" maneuvering ability (including a station-keeping option). As already noted, additional benefits include substantially reduced fuel consumption, lower engine-noise levels, the elimination of exhaust odor, and a reduction in engine-room size that can materially increase a boat's accommodation space.

The large, resilient, rubber "O"-ring mounting of the IPS and Zeus drive systems contributes to their unusually low mechanical noise levels, as does the somewhat-greater-than-normal clearance between the tips of the props and the hull

bottom. Routing the exhaust gas and cooling water through the drive legs (at engine speeds close to idle, the Zeus system sends the exhaust directly overboard through a water-lift muffler) contributes to noise reduction. Moreover, when the boat is underway, both systems disperse the exhaust far enough behind the transom to eliminate the "station-wagon effect" that draws exhaust fumes forward into the cockpit of many conventionally powered cruising vessels.

The enhanced maneuverability and propulsion efficiency delivered by pod drives result from their ability to deliver thrust precisely where it is needed to accomplish the desired maneuver. As with a sterndrive or an outboard, there is no need to redirect flow from the propeller using a rudder (which typically redirects only 30 percent of the thrust).

Low-speed maneuvering is especially impressive with the joystick control. Again, operating through a computer, the stick independently — and simultaneously — controls the direction of rotation, speed and steering angle of the drive assemblies, whether there are two, three or even four of them.

(Tiara's 5800 cruiser has three, Lazzara's 75-foot motoryacht has four, the Legacy and Sabre 42s each have two, and so does the Grand Banks 41.) The boat goes precisely where you want it to go, including rotating about its center, without the need for bow or stern thrusters and without the helmsman touching the throttles or gear selectors.

Learning to operate a pod-drive boat with its joystick control takes less time than is needed to fully describe in words how to do so. The system is "transparent" and intuitive; there's no need to think about how it works. You simply move the control (only fingertip pressure is required), and the boat will move to satisfy the command. Push the joystick to starboard and the boat "crabs" sideways to the right.

The speed at which the vessel moves is proportional to the deflection of the joystick from its spring-loaded, neutral position. Twist the head of the joystick, and the boat will rotate about its center, with its speed proportional to the degree to which you have rotated the control. Deflect *and* twist the joystick, and the vessel will simultaneously rotate and move in the direction you have commanded.

As hinted above, the maneuverability provided by vectored-thrust systems has permitted the development of an automatic station-keeping option — the Skyhook Electronic Anchor for the Zeus and the GPS Anchor for the IPS. Both use integral GPS receivers and electronic heading sensors to fix the position and heading of the boat at the moment the "on" button is pressed. Once engaged, the station-keeping function will automatically demand from the pods the exact amount and direction of thrust required to compensate for current and wind. (The precision achieved in the station-keeping mode does, it's true, depend on the stability of the GPS position information.)

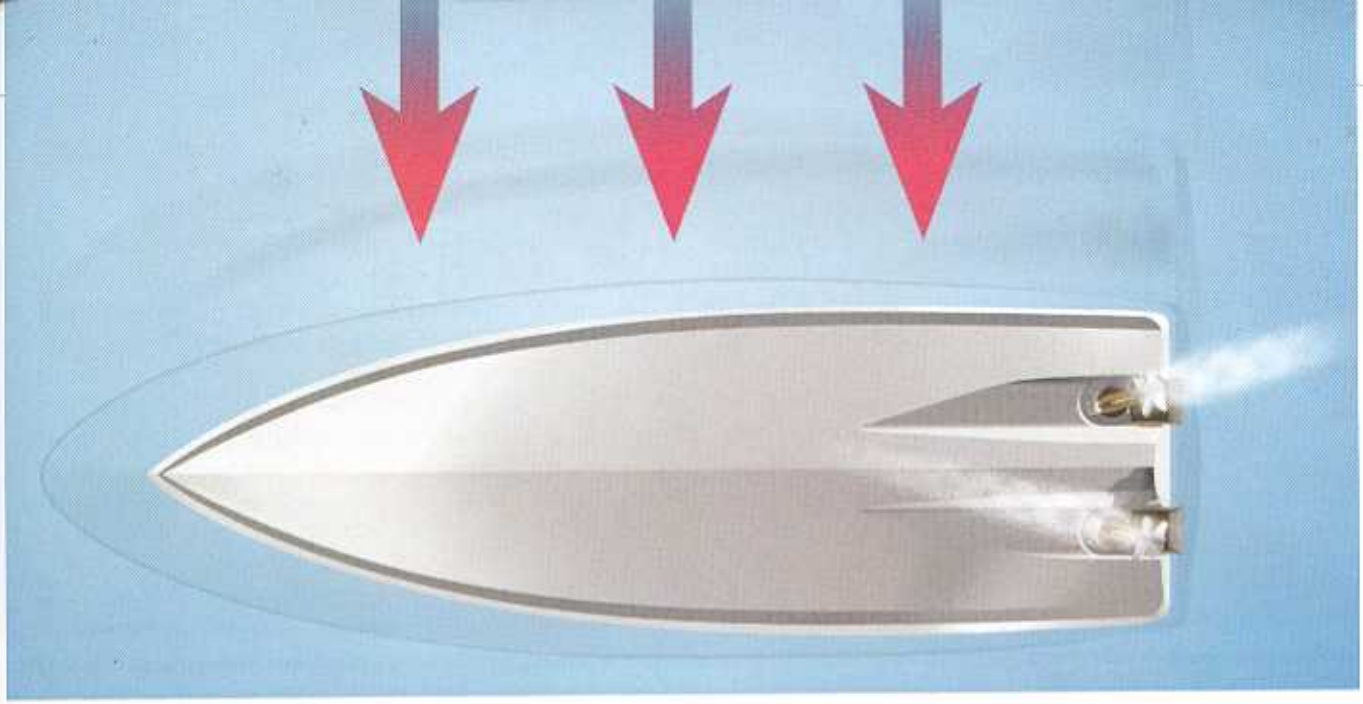
The Lazarra LSX 75 (above) made a real splash last year with its *four* Volvo diesels and IPS drives. The engine room (top) is compact and uncluttered, and the boat is very quiet inside and out.

Extraordinary Efficiency

The outstanding propulsive efficiency of these vectored-thrust systems results from two attributes of horizontal prop shafts. Unlike the thrust from a propeller mounted on a conventional, inclined shaft, where a portion is directed downward, *all* of the thrust from the pod-mounted wheels is horizontal (parallel to the water's surface).

A conventional, inclined shaft creates additional inefficiency by placing the prop at an angle to the *incoming* flow of water, causing the blades on the descending side of the prop "disk" to operate at a higher angle of attack than those on the ascending side.

The result is asymmetric thrust — more push from one side of the prop than the other. Mounting the propeller(s) on a horizontal shaft ensures that the entire disk is working at its optimum angle of attack, delivering maximum thrust from all parts of the blade circle.



Via the joystick (above left) and computer, twin Zeus drives will automatically move a boat precisely sideways, with no bow swing (top). Note that the lower drive is in reverse while the upper one is in forward, and each is directing its thrust at a different angle. The Zeus system's counter-rotating props (above) minimize "swirl loss."

There's another advantage to the props on pod drives: Moderate draft is desirable in the vast majority of cruising boats, and since the propellers projecting below the hull often determine how much water a boat draws, builders normally install the smallest-diameter wheels capable of creating the needed thrust. However, apply too much power to an undersize prop, and a portion of the energy will be wasted, creating a "swirl loss."

The counter-rotating wheels used in the IPS and Zeus systems are surprisingly small, but because the second prop on each shaft recovers the swirl energy of the first, the boat's draft can be reduced without a loss of thrust. All else being equal, minimizing prop diameter also increases the clearance between the tips of the propeller blades and the hull bottom, reducing noise and vibration. (Note that counter-rotating technology is not exactly new; the first patents were granted in the United Kingdom during the late 1830s.)

Scraping Bottom

Given the increased shoaling occurring on many of our waterways, combined with the poor charting in some of the areas that power cruisers often visit or transit, there is a justifiable concern about possible damage to pod drives in the event of grounding. The designers of both the Zeus and IPS systems have addressed this problem differently but effectively by making the drives strong enough to survive damage from minor contact with the bottom while simultaneously ensuring that in a severe impact the under-hull drive legs will shear off without flooding the boat.

Both manufacturers have performed extensive testing to ascertain and document the performance of these drives in impact situations. During in-house testing by Volvo Penta, one of two drives on an IPS boat suffered extensive damage during a severe grounding; the leg was replaced, and the boat was back in service in a couple of days. I have witnessed similar groundings involving a conventional prop shaft and drive, and most required removal of the engines and reconstruction of the hull bottom, taking the boat out of service for months.

The Zeus and IPS systems differ significantly in the orientation of the propellers on the shaft of each pod. Volvo Penta places the props ahead of the drive leg, facing forward, while Cummins MerCruiser puts them in the more conventional position, behind the leg, facing aft. Each manufacturer makes claims for the superiority of its approach.

Analysis of the two systems leads me to believe that the

difference in performance between them is likely too small to be measured using conventional boat instrumentation. Whether one configuration is better than the other in avoiding or minimizing damage from minor encounters with debris in the water or with the bottom remains to be seen over the next few years. Volvo Penta, whose IPS system has been in service on numerous boats in all parts of the world for some time, reports very few instances of prop damage.

The two systems also differ in the design of their trim tabs (common on planing-hull boats and desirable on some semi-displacement hulls). Most IPS installations use Volvo Penta's "Interceptors," which are electrically powered, blade-type devices installed vertically on the lower face of the boat's transom. The blades are extended downward, below the edge of the transom, when bow-down trim is needed.

By contrast, in the Zeus system, each pod has an integral, hydraulically positioned trim tab of more or less conventional design located immediately above and aft of each pair of props, where it creates maximum lift with minimum deflection.

Dialing for Dollars

The price difference between a conventional propulsion system and a vectored-thrust system will become evident as more boatbuilders offer the same model both ways. There are good reasons why the price of the pod-drive version may be little different from the one with standard running gear.

Although the new drive systems — and especially their bronze and stainless-steel lower units and counter-rotating props — may be more costly than the conventional components they replace, there are significant savings elsewhere, particularly in installation. For example, there are no rudders to buy, install and adjust. There is no need for a through-hull, seacock and strainer for engine cooling water, since all of these components are part of the drive system.

Nor is there a need for a conventional muffler and exhaust system, because in a pod-equipped boat, the exhaust exits from the center of the underwater drive, as in an I/O (although — as already noted — the Zeus uses a small, idle-speed water-lift bypass muffler and exhaust with some engines).

Moreover, a boat's diesels are connected to the pod drives through universal joints, eliminating the time-consuming task of precisely aligning each engine and prop shaft, as well as allowing the use of very compliant engine mounts that reduce the transfer of engine vibration to the hull.

Because both steering and engine shifting are electronic, there are no mechanical or hydraulic components to install. The boatbuilder simply plugs in the connecting cables, and the job is done. Due to all these factors, some manufacturers have reported that a complete twin-engine pod system can be installed by two workmen in less than one eight-hour shift.

That said, most boatbuilders have to reconfigure their hulls for pod drives of either brand to ensure that there is a clean flow of water to the propellers (particularly important for the forward-facing IPS drives) and that the legs sit more or less perpendicular to the water's surface. This, of course, means some initial expense in fiberglass tooling.

Bentley Collins of Sabre Yachts comments, "Pricing is an interesting topic. The engine suppliers want a lot more money for these pod systems. In our 42 Express, switching to Zeus drives will cost about the same as an engine upgrade from the standard 440-hp Yanmars to the 540-hp Cummins engines. The pod drives will give the client the same performance, but they will be burning 20 percent or so less fuel.

"For mass-production builders, the labor savings [in pod-drive installations] are going to be more meaningful," says Collins, "because they represent a larger percentage of the total build cost than is the case at Sabre, where we 'stick-build' the entire boat. Our upgrade price is just under $50,000. The bonus, of course, is that the client doesn't need to buy a bow thruster, a stern thruster or an autopilot.

Tiara's new Sovran 5800 (above) is the first U.S.-built cruiser to be equipped with three IPS drives. The engine room (right) takes up little lineal space in the boat and provides plenty of access for maintenance of the Volvo diesels.

In 2008, Sabre's tried-and-true 42-foot express cruiser will be offered with twin Zeus drives, which — because they are mounted in the stern — will allow a bulkhead shift and permit enlargement of the living accommodations below.

"The maneuverability is extraordinary," notes Collins, "and the sound levels are much lower than with shafts. I think the main point here is that buyers want pod drives. It's technology that makes their boating experience better, and they are willing to pay for that."

Sea Trials

Thanks to the assistance of David Hensel, marketing communication manager at Grand Banks, we were able to discuss many of the details of the new Zeus-equipped GB 41 with Earl Alfaro, the naval architect in charge of the project. Earl began his design effort with an evaluation of a number of hull forms, and that included tow-tank testing in the Davidson Laboratory at the Stevens Institute of Technology, Hoboken, New Jersey.

Determining how to integrate the hull tunnels required for the Zeus drives was one of Earl's many design challenges, and here he relied heavily on the computer-based tunnel-modeling technology developed by Cummins MerCruiser. The objective was to design a hull form that would provide a 24-knot maximum speed and a sustained cruise speed in the 18- to 22-knot range. The 41-footer's Zeus drives will be paired with QSB 5.9 turbo-diesel engines to meet that objective.

Earl has taken advantage of the compact dimensions of the vectored-thrust drive system to significantly increase the size of the accommodations in this boat. A conventionally powered vessel of this length might devote as much as 20-21 feet to the engine room and lazarette. In contrast, the propulsion machinery in the new GB 41 will fit comfortably (along with the gear that accumulates on all yachts) in an engine compartment whose forward bulkhead will be only 12-13 feet forward of the transom. In terms of living quarters, the GB 41 will be a very big vessel down below.

The space economy of vectored-thrust systems has also been convincingly demonstrated in the aforementioned Lazzara motoryacht, where the Quad IPS engine room (more accurately a compartment; it's too small to be a "room") occupies just 9 feet of the hull's 75-foot length, allowing the lower deck to stretch some 62 feet, from the forward engine-compartment bulkhead all the way to the bow.

I have tested not only the initial versions (essentially prototypes) but also the latest production iterations of the IPS and Zeus. All were easy to use from the outset. That said, the first installations of both brands exhibited a rather abrupt response when deflection or rotation of the joystick signaled the computer to engage the clutches in the drives.

Production versions of each system have been improved via the addition of a clutch-slip mode similar to that of a trolling valve. The "feel" will be familiar to pilots who fly joystick-equipped aircraft: You don't really have to think about how you are moving the stick. You merely decide where you want the plane (or in this case, the boat) to go, and the connection between your mind, arm, hand, stick and pods takes you there.

I have watched a number of people who had little or no boat-handling experience use these vectored-thrust systems. Although they were understandably timid at first, in less than 10 minutes they were maneuvering fairly large boats (like the Lazzara 75) with considerable ease. Their greatest challenges appeared to be accommodating the initial drive-engagement response and judging the inertia of the boat itself.

Based on all this evidence, I believe that the advantages of vectored thrust for a cruising boat are, at the very least, substantial. Docking, even in a current and/or breeze, will no longer present a stiff challenge to even the most short-handed, inexperienced crew. Noise and vibration will be greatly diminished, and exhaust odor will no longer be a problem, regardless of the relative direction of the wind. There will be more space for the accommodations and, based on installations we have examined, for the engines themselves.

Boats equipped with vectored-thrust drives will consume less fuel and may be equipped with smaller engines than those needed with conventional drives. The ability to engage the optional station-keeping mode will make docking and even anchoring much easier. In short, when the time comes for you to move on to a new boat, try one equipped with either of these new propulsion systems; you won't regret having done so.