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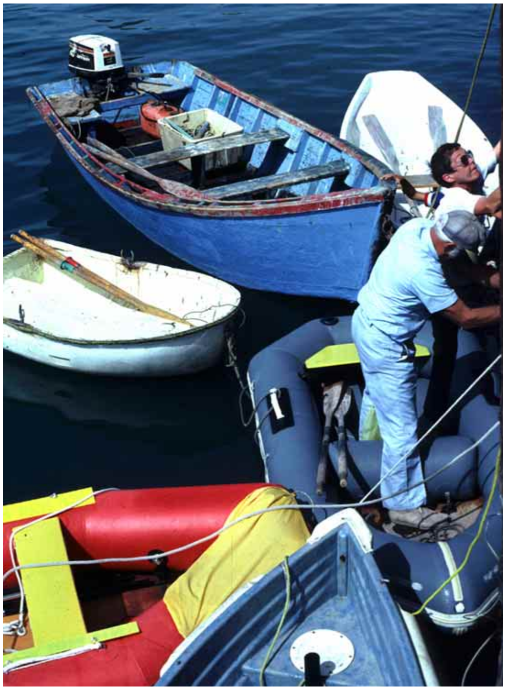
Dinghies



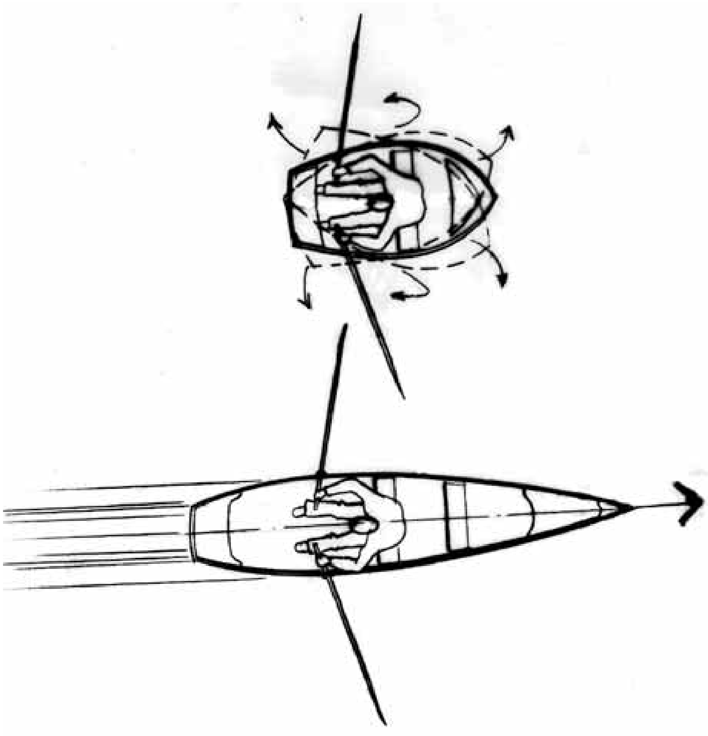
The dinghy has to perform a number of important functions. From a safety standpoint, it must be able to go to windward under adverse conditions when towing a spare anchor warp. It may become a life raft or an important adjunct to the raft. And, of course, it's your mode of transportation when anchored.

Let's explore these requirements in more detail. To begin with, sooner or later (probably sooner) you will find yourself aground. Under certain conditions you may urgently need to launch the dinghy and put out a kedge anchor. If there's a sea running or you're fast on a reef, a few minutes can be the difference between another learning experience and disaster. Since you may find yourself in a situation of having to row against a strong wind and breaking seas, the dinghy has to have some seakeeping ability. In addition, it must be stored and secured in such a manner that it's ready to go over the side quickly.

This last point was brought home to us in a very embarrassing manner some years ago. We had just made a radar and depthsounder entrance to fog-shrouded San Diego Harbor. I was tickled at our successful use of these new toys, even though I had been in and out of the Point Loma breakwater many times in other boats with nothing guiding me but my ears and nose.

The fog lifted as we worked closer to the Shelter Island Basin. I had Elyse, then seven, read the depthsounder (for practice) as we headed for the marker dividing the channel entrance. When Elyse started reading three instead of 30, I thought she was confused until there was a thud and *Intermezzo's* bow lifted a foot out of the water.

Two approaches to using the dink as a life raft. The inflatable tubes (top and bottom) add buoyancy and make the dink more difficult to capsize. The "Tinker" inflatable (far left) is available with an inflatable canopy and emergency inflation device.



Directional stability and handling ability in the surf are related. Both are derived from beam-to-length ratio. The longer and narrower your dinghy, the easier it is to row and control in surf.

Kayaks are great fun, and if you get one designed for the surf they are a ball on the beach. And for just cruising around the anchorage, on your own, they are hard to beat. Storage is some times an issue, but with one of the shorter models you can carry them across the transom in protected waters.

I had forgotten "red right returning," and we were hard aground on a mudbank. It was apparent that the tide was at the top of the flood and ready to start ebbing any moment. We couldn't back off, so I began to get the dinghy overboard. Out came the sail covers, awnings, fenders, three sets of oars, sailing gear, dinghy anchor, and dock lines. By the time this was all on deck it was difficult to get near the dinghy, let alone try to tie up the lifting sling. It was 10 minutes before I had the boat over the side and had set a kedge. As it turned out we were able to get off that tide, but another few minutes of messing with the dinghy and we would have been stuck for the night.

Thereafter we always stowed the dinghy with only essential items and left the sling attached.

How Will You Use It?

There are so many ways of utilizing dinghies that before you can start to make an informed choice on the design of dink, you need to decide what you will use it for.

The Dink as a Life Raft

It's not a bad idea to consider the use of a good dinghy as either a life raft or in conjunction with a raft. The Robertson family in *Survive the Savage Sea* tell how they used their solid dink first as an annex, and later as their primary life-support vessel when their raft deteriorated (more on this subject will be found in the chapter on life rafts).

Harbor Transport

The dinghy will be used most often as a means of

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transport in harbor. On a basic level, the dinghy will take you ashore and to visit neighbors. That's a necessity. You'll also find yourself getting much enjoyment from exploration trips, jungle river rides, poking through mangrove swamps, or lazy cruises over the reefs. These are among the finest moments in cruising, but since some of these exploration trips will be in secluded areas, you must have a dinghy to get you back, regardless of what happens.

Beaching

The ability to take repeated beachings on sharp rocks or coral must be considered, along with the capacity to be pulled on and off the shore by lighter members of the crew. Linda is just able to handle our 115-pound (52.2kg) dinghy if the beach surface is rough sand or coral. If it's smooth sand or mud, she needs help. Inflatables are often more difficult to pull up and down a beach than solid boats of comparable weight because of greater bottom surface area and resulting friction.

Buoyancy

Next, the dinghy must be easily rightable when capsized. Any centerboard-dinghy sailor knows the importance of this, but it means more buoyancy than is generally built into the standard dinghy. If you're planning to build a dinghy, or to add buoyancy to your present one, use the biggest tanks you can fit. Not only do they help in righting, but they also help keep the boat afloat and upright when swamped in the surf.

We've seen dinghies with handrails fastened to their bottoms to act as runners on coral beaches and handholds to flip the dinghy back up in the water. The less freeboard the boat has when it is righted but still swamped, the more difficult it will be to bail it dry, even with large bailers.

Another consideration is getting ashore or back out to sea when a sea is breaking on the beach. Speed and directional control are the essential elements.

We saw our first set of dinghy wheels in Hawaii ten years ago (where these photos were taken) and were immediately impressed. The large-diameter pneumatic tires rolled easily on the sand, making it possible to drag a heavy dink/outboard combination quickly out of the beach break.

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With most inflatables, rowing is almost impossible. However, if the seat geometry is right and the boat has a solid or reinforced bottom and long oars (as shown here), it is not impossible.

INFLATABLES

The inflatable dinghy has opened up a new dimension in sail. A yacht can have a good-size tender with an easily stowed inflatable. It's not unusual to see a combination of inflatable and solid dink on 35-footers (10.7m).

Inflatables are lightweight, make reasonable temperate-weather lifeboats when properly prepared, and, when powered adequately, do very well in the surf. Rowing an inflatable is another question. Of primary importance here are the size of the oar blades and the length of the oars. The standard oars on inflatables are much too short. At least 7-foot-long (2.1m) oars are necessary for the average 8-foot (2.4m) inflatable.

Solid floorboards make a tremendous difference in the performance of the smaller flat-bottomed inflatables, both under power and rowing. These can be simple pieces of 3/8-inch (9.5mm) plywood or more elaborate pre-made floorboards available from the manufacturer.

Sport Boats

The boats I like the best are those with the V-bottom shape that comes from inflatable or timber-reinforced keels and solid floorboards. These dinks all get up on a plane quickly and have a much greater range of utility. Most 10-footers (3.1m) will move two people at 13 knots with a 6-horsepower engine. With that sort of speed at your disposal, the dinghy becomes more like an automobile for going to town, getting supplies, or visiting. There are many spots on the cruising circuit in which the best anchorages are some distance from the center of town, and local shore transportation may be infrequent or nonexistent. Without a good high-speed dinghy, the in-town anchorage becomes mandatory. Tahiti is a good example of this. The anchorage in downtown Papeete is crowded and noisy; after a few days tied up stern-to, it wears thin on charm. You can take a 15-minute ride by inflatable in either direction from Papeete and find quiet, beautiful anchorages.

If you go one step up in size, to an 11-foot (3.4m) boat, you can then add a 20-horsepower motor for better speed and a variety of watersports. This size also makes for a much drier ride.

A planing inflatable is probably the best boat for handling surf. It has excellent maneuverability, and acceleration, and its extra speed means you don't have to time your moves with the waves quite as precisely as with conventional boats.

The negative side of the inflatables is cost. They're initially expensive and don't last forever. You must be careful with them around coral and jagged rocks. And although they will take a tremendous amount of punishment, punctures do occur. Simple punctures are fairly easy to repair, however, and facilities for repairing inflatables exist in major ports all over the world.

RIBs

Rigid-bottom inflatables have come a long way in both design and price, to the point where its not uncommon to find them on 40-footers (12.2m). The tubes can be deflated so that only the bottom will need deck space.

The bottoms typically run to semi-deep V in shape. There is considerable variety in the hull shapes and how they perform. Before buying a RIB (or any inflatable for that matter), try one out in some chop. How dry they keep you is going to be extremely important later on.

Inflatable Features

There are considerable differences in construction techniques and design features. Be sure to check out the type of material being used and the bonding system for longevity. In the old days Zodiac used to build bulletproof inflatables. Then they "modernized," and quality went way down.

Sometimes you may need to pay a premium for quality, but after a couple of years the better inflatable will be still going strong.

One important feature is tube diameter; bigger is better. It makes for a stiffer and much drier boat.

It is sometimes a help to have D-rings laminated to the tubes to help secure the inflatable on deck. At the same time, you may want to have neoprene-rubber letters glued on to tell the world just whom this dinghy belongs to!

Towing Eyes

When towing your inflatable dinghy, make provisions to run the towing line through the forward towing eye(s) and back to eye bolts in the dinghy's transom, being sure to put PVC-plastic chafing gear over the lines where they are in contact with the hull. Damaged towing eyes are a common problem, and this system will minimize abuse.

We've had an 11-foot (3.4m) Nouvarania for the last 10 years (the same one!). This inflatable has a timber keel that pushes the bottom into quite a deep V-shape. The result is a dry, relatively smooth ride.

Look at the difference in bottom shape. The bottom dink has an inflatable tube to lend some shape to the bottom. The top dink has a flat bottom which will go hollow with load. This is wet and slow.

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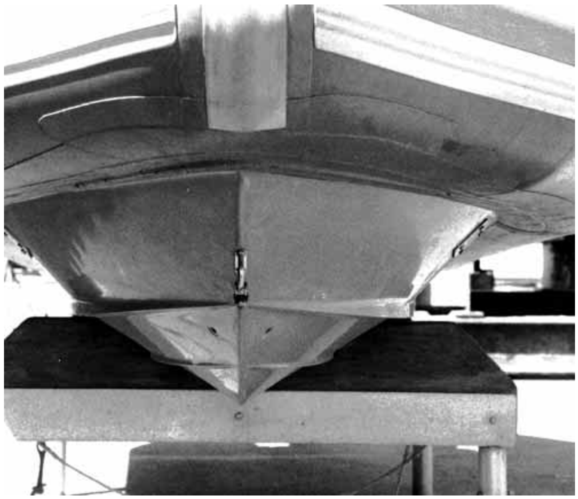
West Marine has developed a line of moderately priced RIBs that are quite popular with the cruising set.



RIBs offer the efficiency and smooth ride of a deep V bottom. However, check the ride before you buy, as hull shapes vary from one design to the next.

It's not unusual to see a collection of water gear trailing astern these days (above). In this case, a Nouvarania, our solid Wherry, an inflatable canoe, and a Hi Plane (for playing crack the whip behind the outboard) lie aft of my dad's boat at a family rendezvous.

Sometimes an inexpensive inflatable can do wonders for the younger set. Elyse and Sarah spent many happy hours rowing this $60 special while tethered to *Intermezzo*.

Dug-out canoes can frequently be acquired by trading. They make wonderful dinghies and are quite easily towable in moderate seas.

SOLID DINKS

As the cruiser gets more experience, if a choice of dinghies must be made, he or she begins to work away from the inflatable. Most of our friends who have "been there before," including the Liggets and the Moeslys, carry solid dinghies. These last almost forever, are easier to pull up on the beach and easier to get aboard, and are much cheaper. The size varies with deck space, but a 9-footer (2.7m) is about the minimum, with 10 feet (3.1m) a lot more desirable. One of the problems with solid dinks is their length/width ratio. Most commercially made units are designed to carry as many people as possible, with a minimum of tippiness. This is fine in a calm anchorage, but the squat shapes are difficult to row, especially into a chop, and difficult to handle even in small surf.

Aboard all our boats we have devoted space to a 14-foot (4.3m) Wherry, or pulling boat. A joy to row, good in the surf, with reasonable performance under power, it gives us close to the best of both worlds. We lash fenders to the gunnels of the wherry to provide extra buoyancy in case it's needed to augment our raft.

The crew of the 47-foot (14.3m) *Dawn Treader of Lune* created an interesting dinghy when we were together in the Bay of Islands, New Zealand. They made up two punts, or square-ended dinghies, that nested inside each other. When they wanted to go exploring, they bolted the boats together, transom to transom, and added a 6-horsepower outboard. Their lightweight, flat-bottomed 14-footer (4.3m) literally flew over the water with that small engine. At other times it split into two dinks.

The Second Dinghy

A lot of boats with children aboard carry a second dink. Allowing the kids, even when they are young, to go off on their own is great for them and for you. In this case, the choice is usually one inflatable and one solid. We made use of inexpensive lightweight inflatables for our children.

Sailing Rigs

Many carry sailing rigs for their dinghies, and in theory it's a great idea. But our experience seems to parallel that of others; we found that the dinghy was rarely set up to sail. When it wasn't sailing, we had sails, mast, boom, rudder, and centerboard to stow.

Kayaks

For exploring, working a beach break, and all-around fun, it's hard to beat a kayak. We've met sev-

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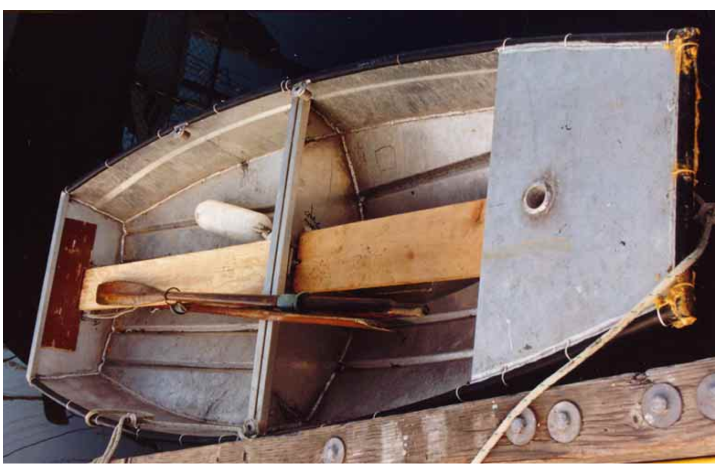
eral cruisers who carry a kayak as a second dink, and they love them. There are several plastic ocean-going models available that are lightweight and moderately priced. You can also find kayaks in knock-down form, both in single- and two-person configurations.

Windsurfers

Our old buddy Larry Porter says that the only reason to cruise is to provide a good platform from which to windsurf. A windsurfer is probably the best exercise you'll get while cruising, and a hell of a lot of fun. How else can you sail at 15 or 20 knots and be just a few inches off the water? The main issue with windsurfers is stowage. They usually end up tied to the lifeline stanchions. This is okay in temperate weather, but even a moderate breaking sea, if it finds that windsurfer, is going to wipe out the stanchions to which it is tied. Offshore, it is better to stow the windsurfer amidships, perhaps under the mainboom, where it is more protected and where there are secure padeyes to which it can be seized.

Three different approaches to a hard dink. The pram (Sabot) at upper left carries more payload for a given length, since the hull has more volume. The dink in the middle right will be easier to row, go faster with a small engine, and be drier. But two *medium*-sized adults is about a maximum payload.

We've used a wherry-based fiberglass design (above right) since *Intermezzo*. This dinghy is loads of fun to row, goes like a bat under power (a 6-horsepower engine pushes it up on a plane), and is good in the surf. The only problem is at 12 feet (3.7 m) in length, it is a handful to stow. The ultimate buzz, however, is the sailboard which Sarah is giving a workout (in her pre-teen years).



An alternate approach is to use a folding dinghy. This allows you to have a nice big dinghy in port but minimize deck stowage problems when at sea. The aluminum design (left) is light, strong, and has so much bottom area that it planes easily under power.

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DAVITS

Davits provide a convenient means of lifting the dink out of the water as well as a potential locations for solar panels and various antennae. However, carrying a dinghy on davits offshore can lead to problems in heavy weather.

Another issue is boathandling in close quarters. A lot of modern yachts have dinghies that are wider than the davits and so overhang the stern. This can lead to so embarrassing situations, especially when docking. We've seen several owners wipe out very nice dinghy/davit combination on pilings as they were docking.

If you do have an overhanging situation, consider dropping the dink into the water and towing it, alongside or astern when docking.

When you head offshore, ideally the dinghy will be deflated and stowed below.

A more complex davit arrangement on the aft end of a Farr 46. Davits like these, welded onto a radar arch, can be quite easy to execute. There are two problems with this design. One, the dinghy is so close to the transom that access onto and off the swim step is impaired. Second, the radar unit shades the solar panels.

The inboard end of an interesting davit system. A simple but robust hinge holds the dinghy in place, locked by the stainless-steel pin. A mizzen halyard is attached to the davit to raise or lower the dinghy.

There were rumors in Malololailai, Fiji, where we took this photo, that the above dinghy had been purchased at a second-hand shop in Roswell, New Mexico (for those of you who don't know about Roswell, it is the sight of a famous UFO controversy stemming from the late '40s). The davits are simple, mild steel-pipe weldments.

Commercial or homemade cavitation plate enhancements like the one above improve prop efficiency and will help keep the dinghy nose down.

OUTBOARDS

If you have a good rowing dink, an outboard is a luxury. But if space limits the dinghy waterline or your choice is an inflatable, the outboard becomes a necessity.

There are so many makes and models on the market today that it's hard to single out any specific unit as best. In general, though, most cruisers agree that even in the small outboards a 2-cylinder model is worth the extra weight. It isn't at all unusual to see a two-banger operating on one or one and a half cylinders. With a one-lunger you don't have that security.

Horsepower

How big an engine is necessary? That depends on how fast you want to go, what sort of stowage is available, and the difficulty in getting the outboard onto the dinghy transom.

Generally, the smaller and lighter the engine, the better. Four to 6-horsepower is plenty to move most hard dinghies at top speed, and a 6-horsepower will get a well-designed inflatable onto a plane with two people, although 8- or 9-horsepower is more ideal for most inflatables.

From this size range the next jump is to the 15- to 25-horsepower models. These typically weigh in at around 90 to 120 pounds (40.8kg to 54.4 kg) and must be handled with a sling and halyard. The larger, heavier engines obviously take more stowage space and burn a lot more fuel.

Many of our cruising friends carry two engines: A small one, easy to handle and economical on fuel; and a larger one for moving fast over long distances. Without an inflatable to worry about we started with a four and graduated to a six. That six would make our hard dink fly! But now with an inflatable aboard we're using a 25-horsepower engine that allows us to water-ski. Our rowing dinghy is still oar-powered.

Emergency Auxiliary Power

Another consideration for the outboard is its usefulness as an emergency auxiliary. Even a 4-horsepower engine will move a 50-footer (15.3m), albeit at just a couple of knots. The bigger the engine, the better your dink will be as a tug, to help you maneuver in tight spaces.

The best way to figure out what you need for this purpose is to borrow a friend's dink and engine and then test the procedure. Try tying the dink amidships with long lines and then slowly accelerating forward. Check out how long it takes to stop as well. Then use the dink to push the bow or stern sideways. It also makes sense to try pushing the boat sideways from amidships.

You'll be surprised at how much maneuverability you have.

Oil Ratios

Two-cycle outboards get their lubrication via oil mixed with gasoline. Most use a 50:1 mixture (although Yamaha specifies 100:1). The oil used for this purpose is a different grade than used in your diesel. Be sure you use the right stuff, or fouling of plug and rings will occur rather quickly (2-cycle outboard oil is available almost everywhere you cruise).

Oil Injection

There are several models of 2-cycle engines available with oil injection. In this case, there is a separate oil tank under the engine cowl which you periodically fill. This supply is then injected into the gasoline before the gasoline is sucked into the engine. It does save the mess and hassle of adding oil to the gas tank, but it introduces another layer of complexity to the outboard.

When you are looking at this feature, consider the fact that rarely, if ever, are these types of engines sold in Third World countries.

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Four-Cycle Outboards

Four-cycle outboards are becoming more available. They are somewhat heavier than 2-cycle outboards for a given horsepower but offer better torque characteristics. This torque issue becomes more important as the outboard sees heavier duty, like being used to propel the mothership.

The big advantage of the 4-cycle engines is that they burn plain gas; no oil is added. They get their lubrication from an oil sump, just as a car engine does. They are also more fuel-efficient, and tend to be more reliable than 2-stroke engines.

As time goes on, environmental pressure is going to force the outboard manufacturers to come up with more efficient, lighter, 4-cycle machines. Keep an eye on them.

Handling the Engine

The easiest way to get an engine onto a dinghy is on deck, if there is room. I like to load everything in before lowering the dink. The engine is bolted on, fuel tank installed, and oars, anchor and life jackets all thrown in. Then the sling is attached, and the entire assembly lowered at once.

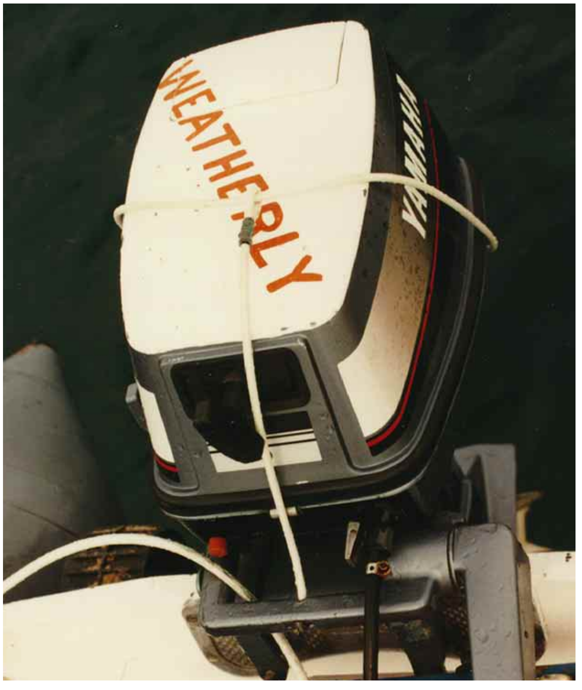
But if there isn't room, the engine will have to be lowered onto the dinghy transom. In this case, secure the dinghy fore and aft so it can't move. Then position the transom even with the halyard being used to hoist the outboard. This will make your job a lot easier.

If the engine is light enough to hand down, use a safety line to secure it to the deck, just in case someone slips.

As the engine gets heavier you will want to rig a bridle that holds the engine upright, in roughly the correct plane to drop over the transom. This usually means tying to the lifting handle in front, then looping over the top and under the aft side of the engine's powerhead. When you make your bridle, test it with the outboard in a variety of different attitudes to make sure the engine can't slip out.

Finally, be sure that the engine clamp is in the correct position to drop over the transom and that the clamp bolts are fully opened.

Handling an outboard can be a chore, especially if it is choppy.The first thing you need is a good sling. A halyard or boom attached to the radar mast (top photo) can then be used to control the outboard until it is clamped on the transom.



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Fuel Tanks

Plastic fuel tanks are a must. In spite of your best efforts, it's impossible to keep steel outboard tanks from creating a rusty mess. The air vents must be protected from damage when the tanks are stored. They're easily broken, leaving you with a leaking tank. Spare caps and/or vents are a good idea. The hose and fittings that attach the engine to the tank deteriorate with age. Carry a spare here, too. We used to carry a single 6-gallon tank, with a second 5-gallon (18.9L) plastic jerry jug. This was plenty of fuel for a month or more of cruising use with the 6-horse engine. Now that we use the 25-horsepower engine we carry the 6-gallon tank and three jerry jugs. Given a fair amount of water-skiing, this lasts us for about three months.

Outboard Fuel Filters

Both Racor and Dahl make compact in-line fuel/water filters for outboard gas lines. These have a lot more capacity than the filter inside the hood of your outboard, and they are a lot easier to clean, too.

Spares

You will also want some spares aboard. Several sets of spark plugs, points, water-pump impellers, perhaps a gasket set, and a spare prop will all eventually see use. If your outboard has a shear pin, carry a bunch of these. Most modern outboards have electronic ignitions consisting of an electronic module of some sort and sometimes a large condenser. If you're heading away from civilization, you may want to carry these. Finally, be sure to carry an overhaul manual.

ELECTRONICS

To someone brought up on celestial navigation who saw people paying the equivalent of $50,000 for a satellite navigator, today's plethora of high-performance, reliable, and cheap electronics are a marvel.

Even a few years ago the concept of being able to precisely fix your position, 24 hours a day, anywhere in the world, was an unobtainable dream. To be able to do it for under $200, with a battery-powered device that fits in the palm of your hand, is truly a cruising miracle.

The problem is recognizing when and where to use modern electronics. There are times when they are great and others when you really do need to step outside and let your senses help with navigating. Electronics can never totally replace your eyes, ears, smell, and hearing. There has to be a balance.

Regardless of how much gear you have aboard, or what the level of redundancy is, you still need to practice the old-fashioned piloting skills. They'll make you a better navigator when using the electronics, and if they should ever fail...

PERFORMANCE INSTRUMENTS

Required for safe cruising? No. Nice to have aboard? Maybe. There is nothing sailing instruments will tell you that you can't find out from some wool on the rigging, a masthead fly, and a good old taffrail log. Sure it's fun to watch surfing speeds, but at the end of a watch the distance logged isn't going to change.

We started out with speed and wind gear on deck as well as below. By the time we were aboard *Intermezzo II,* we had decided to buy instruments for apparent-wind speed and direction, as well as a boat speed/log to have in the navigation area but not on deck. That worked out fine, as it gave us a chance to keep an eye on the autopilot's performance without going topside. Costs were low, and keeping the gear below helped reliability. It was, to a degree, a convenience in watchkeeping, although certainly not essential.

Many years later I still debate the wisdom of investing in sophisticated instrument packages. When we do, it is mainly because we want to be able to develop real-world performance polars to compare with our computer-generated data.

If you're at all new to sailing, and you have performance instruments aboard, try covering them up and sailing by feel. It's fun, and you'll learn much more quickly what the boat needs to keep it happy.

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Integrated Systems

On many of the larger yachts we've built, fully integrated computerized performance systems have been installed. Yet in many cases we've observed that these systems have been a waste of money. Only a small percentage of the available data has been used by the owners. Not that I am totally opposed to this modern gear. It's just that I haven't seen the practical *need* for fancy performance-electronics aboard. Recently, though, the new crop of performance instruments have gained the ability to *integrate* wind speed and direction, boat speed, and course data, and to deliver interesting and valuable interpretive information. If you add the capabilities of a personal computer to the equation, a whole new series of possibilities in performance cruising and navigation open up.

VMG

At the simplest level, many instrument makers now offer an option that calculates velocity made good (VMG), taking into account your boat speed, the apparent wind speed and direction, and that calculates your progress directly up- or downwind. If you've ever wondered if your speed toward an upwind destination was actually faster when you pinched up and slowed down, or eased the sheets a bit and increased speed, just keep an eye on the VMG readout for the answer. The same holds true for downwind destinations. Most modern yachts are faster and more comfortable if they are jibed back and forth instead of running dead-downwind. What's the best angle? Again, the VMG meter will calculate this for you; at least that's the theory. In reality they will give you some rough data on VMG, but the numbers move around so much due to changes in wind speed and wind angle that a good chunk of the value is lost.

The VMG readout has to be used with a degree of caution, and the figures on which you base your decision should be averaged over a period of time. Brief changes in course, wind speed, or direction can have large, albeit momentary, impact on VMG readouts.

If you step up one notch and choose a more sophisticated system with a powerful computer built right in, there is a host of features that can help your cruising. At the heart of this upgrade is the integration of a compass course with the other data. This makes it possible for the computer to calculate values for true-wind direction and dead reckoning.

Dead Reckoning

Dead reckoning between long-range navigation fixes has its obvious advantages. But an accurate DR log can also be of immense importance. In a shorthanded man-overboard situation, especially if it has taken a few moments to get the boat stopped and turned around, this feature could literally mean the difference between life and death.

True-Wind Direction

For me, the most valuable data to come out of these systems is true-wind direction. The computer calculates true-wind angle, notes what your course is, and then presents you with the TWD result. This TWD readout is the best way to keep track of wind shifts on a passage. It allows you to decide whether you're in a momentary change or in a long-term transition. When the time comes to calculate appropriate tactics *vis-a-vis* the weather, this is the key data you'll need.

Performance Analysis

Once you have this computer power calculating DR and TWD, you can also compare your sailing performance to the computer's estimate of how fast you should be going. While this may sound like a feature necessary only on a high-performance racing boat, it may actually be of more value to cruising folk.

Tell the computer the size of your boat (or rating) and it will come up with some estimates of performance keyed to wind strength and direction. Or, with most systems, you can key in velocity-prediction data generated by your designer or from the IMS rule. The computer will then compare your performance to the internal performance polar and give you a percentage rating. If you are a bit off the wind, maybe beam reaching, you will get a percentage of reaching speed.

What makes this so desirable on a cruising boat? Now you have a performance gauge for comparison. Offshore, it's rare to have another boat in sight with which to compare performance.

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Using the performance-comparison data allows you to sail against the optimum. It isn't likely you'll beat the computer-generated numbers often, but it's fun to try. And trying leads to a better understanding of the right sail combinations, sheet leads, and sail trim. The less racing experience you have, the more valuable these features become.

Performance Targets

Two other valuable bits of data that the sophisticated systems generate from the performance polars are target boat speed and target wind angle. Target boat speed is the optimum speed you should be sailing to windward, under ideal conditions in smooth water. If actual speed is higher than the target, the odds are that you are sailing too far off the wind and need to head up a bit. If you are sailing slower than target, head off to bring up speed.

Target wind angle is used downwind when jibing back and forth on a run. This is the apparent-wind angle that will give you the best VMG toward your downwind destination. If the wind angle you are sailing is closer than the target, head off, and *vice versa*. While target boat speed and wind angle sound like esoteric racing concepts (which they used to be), they are the most efficient and frequently the most comfortable way to get to your destination.

True-Wind Angle Correction

The most difficult aspect of calibration is determining true-wind angle. When beating, this is affected by upwash on the rig; when running, by downwash. In addition, wind shear (which varies with height off the water, the atmospheric conditions, and temperature differential between air and water) affects this calibration effort.

The result is that in a cruising context, unless you are prepared to constantly check and recalibrate for the changing conditions of shear, you will never know exactly what true-wind angle is (and hence true wind speed). There are just two many variables. However, some systems, like the B & G 790, allow you to enter in a table of wind-correction data. You can then select from the appropriate conditions for the situation in which you find yourself.

In spite of everything you do, it will be difficult to get closer than +/- 10 percent on TWS and TWD for reaching conditions. Typically, most systems over-read when reaching. Being high by 20 percent on true wind speed is not unusual under reaching conditions.

Spinnaker Sock Effect

When you are broad-reaching or running with a spinnaker, the sock will bunch at the masthead. The turbulence generated by the sock will often render the masthead fly and electronic wind instruments useless. If this is a problem on your boat, it can sometimes be alleviated by moving the sensors to the aft side of the mast.

Masthead Instrument Extenders

One way to get rid of sock interference while reducing the effects of up- and downwash is to put your sensors on an extending rod above the mast. Many racing boats do this. We've found on *Beowulf*, with its broad-headed main, that it is essential for getting any sort of accurate data.

This extension on *Beowulf's* masthead instruments made them much more accurate.

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This can be accomplished with a light piece of aluminum pipe or fiberglass rod. Johnny Lindstrom at Baytronic South in Marina Del Rey, California, has a carbon-fiber extender that incorporates the B & G masthead sensor. He sells this for a couple of hundred bucks over the cost of the sensor, or you can trade in your new sensor. The unit he fitted to *Beowulf* was 6-feet long (1.8m), and it made a huge difference in accuracy, especially when reaching.

Instrument Accuracy

There is a wide variety of accuracy in masthead wind and direction sensors. If you are planning on using your data for tuning or are a bug for accurate data, be sure to check these specifications. Make sure you understand how to arrive at the specifications, too.

Computer Integration

Many of the new performance-instrument systems offer what is called an RS232 port. This electrical connection allows the instruments to talk to your own personal computer, opening up a host of opportunities. With the enormous power of even the smallest portable PC and any of a number of new software programs written just for sailing, the sky is the limit on what you can do.

The PC and sailing software start by digesting the data coming down the wires from the RS232 terminal. Along with the wind, boat speed and heading data we've already mentioned, you can also have your GPS tied into the system. Some systems like the Brookes & Gatehouse 790 allow you to transmit heel angle, water temperature, rudder angle, as well as the output of several load sensors. The software then logs this data as a start. The Compusail system is a good example of how all this can work. The software asks a few simple questions about what data you would like to log and how often. The desired data will then be recorded in the computer's memory (on floppy discs or the hard disc) and/or will be printed out at the same time.

One of the most interesting features of this software is the ability to present a host of data graphically. It can plot wind direction against time, wind strength against time or velocity, and at the same time check your boat speed through the water against time or wind speed. The weather aspects can be especially valuable in checking shift patterns, especially offshore where such graphically presented data, in conjunction with basic meteorological information, can help greatly in figuring out what part of a weather system you are actually experiencing.

Tiderace, an English software system, offers typical course-layout capabilities. You can lay out the waypoints for which you are heading and see your progress on the computer screen. When beating or running, the computer can graphically show when you're approaching the layline (the right spot to tack or jibe).

Software Decisions

If the possibilities of hooking up a PC for manipulating this data tantalizes you, the first step is to choose the right software. The best way to do this is to sit down with a simulated program and use it. (Most software suppliers will sell a test program that can be used on your home PC for a modest cost.) Try out all the various facets. Make sure you understand the instructions. If possible, go for a sail with a working system. Above all, be sure to get a chance to play with the system yourself. Otherwise, you may invest a substantial sum only to see it sit unused in the navigation station.

Once you've settled on the software, get a recommendation on the best computer to use. Make sure that the computer is electronically quiet, so as not to interfere with your SSB, ham, radio, or weatherfax. Then, be sure the PC you have chosen will talk with your instruments. It's best to see the system work as a unit — software, computer, and instruments. If there are any bugs in the overall package (and that isn't unusual), be certain the folks selling you the system guarantee results. A reputable dealer will.

Before we leave this subject, let me add that *Sundeer* was equipped with a sophisticated performance system (Brookes & Gatehouse 390) to help us evaluate her performance in comparison to what our design analysis said she should be doing. Linda and I felt that this data was valuable enough for future design work to invest in the instrument system. We went with a B & G 790 system on *Beowulf*, again for the same reasons.

The data is of great value to us design-wise, but we wouldn't do it again unless there were design issues to be resolved. Why? Because we find ourselves spending more time looking at the gauges and less sailing by the seat of our pants. And the space and funds, in a strictly cruising context, could be more wisely spent.

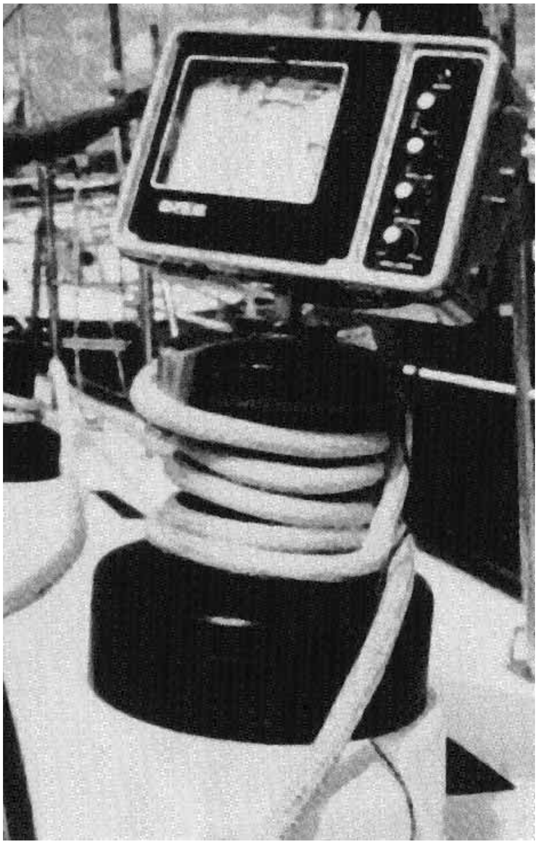
Hardware Decisions

How do you go about putting together one of these systems? The first step is to define just what sort of data you really want to use. The basic VMG option will be of assistance in teaching the best way to move comfortably and quickly up- and downwind. If you want to pursue the next step, be sure the system you choose can be accurately calibrated to your yacht. This means the folks from whom you buy the equipment have to understand the fine points of tuning your onboard performance computer. If the speed, heading, wind speed and wind-direction data are not spot-on, the resulting data the computer spits forth will leave something to be desired.

FATHOMETER

Perhaps the simplest and certainly the most popular navigation aid is the depthsounder. The digital read-out units are excellent when working onshore in moderate depths, but for navigation I find the recording units better.

Intermezzo carried a Furuno recording fathometer. Only once in our circumnavigation did the recording fathometer really pay its way. In the Torres Straits between New Guinea and Australia we were able to ascertain our longitude, based on the bottom curves shown on the depth recorder, in an area of dangerous reefs where no other long-range navigation gear was available. Given my state of mind at that point and the reef risks that existed, I guess you could say the system paid for itself in that one use. (Besides, it came with the boat.)



My dad has always been partial to recording fathometer. For navigational purposes they are hard to beat (although of less relative value in the day of $200 GPS receivers). We made up this mount for his Si-Tex fathometer so it could sit on a primary winch next to the helmsman.

Today, with GPS so easily available, the navigational rationale for anything other than a depthfinder for shallow water has receded.

When looking at this gear, consider output power and/or the sensitivity of the receiver if you're going to be using the equipment for more than shallow water. The more powerful system (if it has a good receiver) will do better with deep readings. On the other hand, a set that boasts lots of power but has a poor receiver won't help.

Most depthfinders have a frequency of around 200 kilocycles. This is fine for moderate depths. But for depths over a few hundred feet and for reading the bottom in mud, a lower frequency will be necessary. Some sets boast dual frequencies that change as needed with depth.

Depth alarms can also be quite helpful. Some of these can be set to show trend change; in other words, to detect bottom slope. The simplest alarms will have fixed settings. But for keeping an anchor watch, a delta alarm, with variable high and low ranges, is the best.

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Installing a radar antenna on a small yacht is always a chore. A radar arch (right photo) provides space for the radar and other antennae. Fitting a cockpit light and working in a helmseat awning also makes sense. An open array (left photo), especially on a ketch, is even more of a challenge. The antenna guard shown above is only necessary of you are using mizzen headsails. The alternative (lighter and cheaper) is to carry lots of spare fuses. While open arrays are heavier, take more power, and cost more, they offer substantially better target definition.

RADAR

Radar gets my vote as one of the most useful aids aboard. While it's not a long-range aid, DR, celestial, or GPS can get you within the range of today's sets.

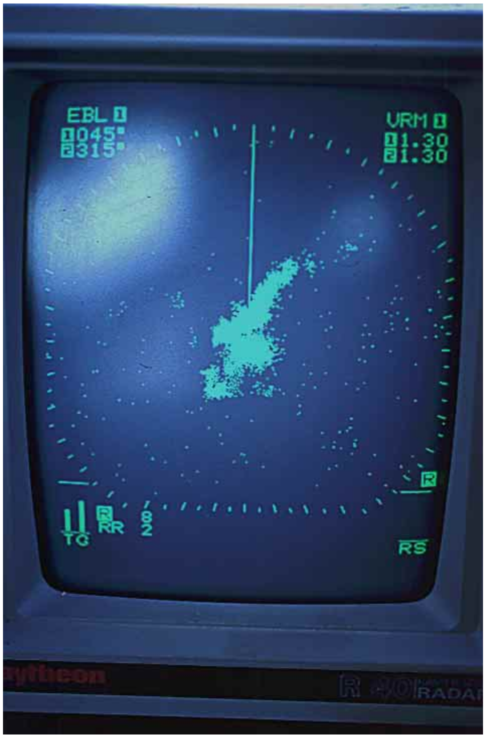
Our system, when making a landfall in the dark or under inclement conditions via radar, is to go within 15 miles of the spot we're seeking via DR or other electronic means, and if no target shows on the radar, we heave-to. In practice, we've always acquired the target within the prescribed time and proceeded on course.

Tilting the radar, if it's attached to a radar mast on the stern, increases the range of usefulness. Most radars begin to lose targets beyond a 15-degree angle of heel. Compensating this way can add substantially to range and target definition in adverse conditions.

The advantage of radar for making landfalls, especially if you're shorthanded, is not to be underestimated. After a particularly boisterous passage from Ureparapara in the Banks Island group toward the Solomon Islands, we raised Santa Cruz just before dusk. Seas were running in the 12- to 15-foot (3.7 m to 4.6 m) range. By using radar, we were able to work our way around the island, staying 3 miles off to avoid any dangers. We ended up in the lee and hove-to for the evening. Leaving the radar on allowed us to take short catnaps before sun-up.

The alternative would have meant heaving-to in a rough sea with the possibility of losing contact with the island, waiting for a morning star fix, and then a long sail back.

Another advantage of radar was brought home to us off the coast of Africa. In a southwesterly gale in the Aghulas Current, we found it impossible to keep watch on deck. We were in the middle of the Cape of Good Hope/Persian Gulf shipping lanes, with supertankers going by hourly. During the 36 hours we were pounding forward under storm stay-



A rain squall on the Raytheon 41X radar on *Sundeer.* Even large targets (like fishing vessels or ships) would be lost in the rainsquall clutter. The Furuno on *Beowulf* does a better job of pulling targets out in difficult conditions.

sail and mizzen, we contacted 10 large ships that had appeared on our radar screen via VHF and advised them of our position.

Radar Weather

Another advantage of radar is as a weather-forecasting tool. With enough range (typically 24 miles) and a sensitive enough receiver circuit, you can see moderate rainsqualls at the edge of your set. At night, this can alert you to the onset of bad weather, with enough time to take the required action.

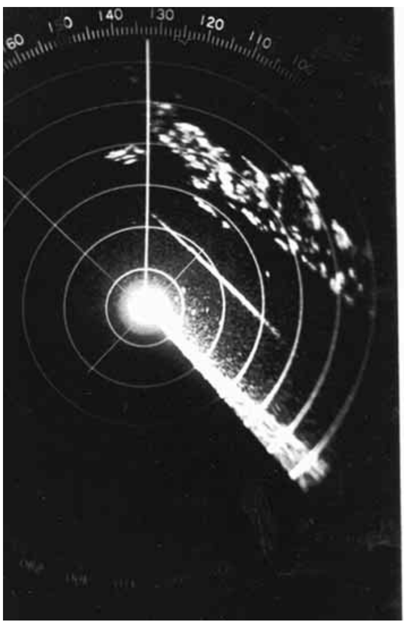
On the other hand, if you are sailing in light airs, you can frequently steer for the side of the squall with some breeze,

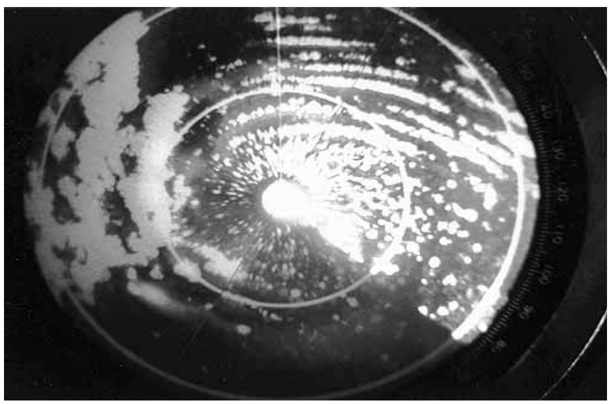
However, not all radars will pick up a moderate shower. Check this feature out carefully.

Target Definition

There are several important features to consider in radar. *By far the most important is target definition*. Most modern radars will paint you a lovely picture of the coastline or a large ship. But how they deal with a small fishing boat, yacht, or sea buoy with large waves running, or in heavy rain showers, is another story. And you usually want radar the most when conditions are rough.

Target definition is a function of antenna size, then the power of the set, and finally the electronic circuitry leading to receiver sensitivity. Just as with depthsounders, receiver sensitivity can make up for a lack of power.





A radar with good target definition can be used to check sea conditions. The left photo shows a breaking reef about a mile offshore in the Fiji group. On the top is a bay along the coast of Baja, California. You can see the swells wrapping around the headland and in towards the beach. Where they start to give a strong return, to the right of the photo, is where the surf is humping up to break. While these photos were taken on Furuno analog radars, modern-quality raster-scan units with large open-array antennae will show something along these lines. Where the raster-scans fall down, unless of very high quality, is trying to pick out a target from the waves, perhaps another boat or a navigation marker.

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The bigger the antenna, the better the definition. Open-array radars are always more sensitive than those housed in radomes. There are several antenna-related factors to evaluate. One is beam-width, an angular measurement, usually between 1 1/2 and 4 degrees. It represents twice the angular distance the antenna rotates between its peak power pulse to when the gain drops by 50 percent. The narrower the angle, the better the radar is able to discern targets.

Another characteristic is the “side-lobe” size. This again relates to the output characteristics. You want the gain to taper off as quickly as possible. Side-lobes are expressed as an angle with a dB rating. For example, a radar with side-lobes that are 20dB lower and within 10 degrees of the direct heading of the antennae will give a pretty sharp definition of a large target. (Since dB are logarithmic, a 10dB change is a factor of ten, while 20dB is a factor of 100, and 30dB is a factor of 1,000.)

You then have to look at receiver sensitivity. This is usually expressed as a “noise figure” or “gain.” The electronics of the radar have an inherent noise factor that must be overcome by the signal from the target. The *lower* the noise figure, the weaker the target the radar will be able to see. A set with a 5dB noise figure would be able to see a target that was one-third the return echo of a less sophisticated set with a 10dB noise figure.

Finally, you have to evaluate the variety of pulse lengths the radar uses. Pulse length, or the time in which the radar actually sends out its signal (measured in millionths of a second) affects how well the radar works at various ranges. The farther away you’re looking, the longer the desirable pulse length, because a longer pulse puts out more power. For close-in work, a shorter pulse length is advisable, because the ability of the radar to measure distance accurately is a function of how short the pulses are. Some simple sets offer just one pulse length while others offer two, four, or more.

Range

When we started cruising aboard *Intermezzo*, her radar had a 16-mile range, which was probably the equivalent of one of today’s LCD units in target definition.

It wasn’t a very efficient set, but we loved what it did for us just the same. Aboard *Intermezzo II* we had a 36-mile Furuno set. The increased range, plus the ability to off-center the image, made navigation a whole lot easier.

Today the navigation issue is not going to be as critical, what with the advent of cheap GPS receivers, but a surprise benefit of this longer range is weather analysis.

Both *Sundeer* and *Beowulf* had 48-mile sets, with the already mentioned off-centering capability. Again weather analysis is helped, but the real benefit of the longer range is the improved ability to see targets in adverse conditions. This is due to bigger antennae, higher power, and better receiving circuitry.

How do you decide what range you need? Forget range entirely and concentrate on target definition under adverse conditions. Once that is at a satisfactory level, any range from 12 miles on will get the job done.

Quantization

There are some manufacturers who use *single-level quantization*. These paint every target at the same intensity, regardless of the actual strength of the target. Others use a *multi-level quantization*, which helps define strong and weak echoes. The multi-level sets usually do a much better job of picking out soft targets from sea clutter. Typically, the more levels, the better.

Sea Clutter Circuitry

Radars vary in how they handle the sea-clutter control. In the simplest sets you adjust sea-clutter up or down in a linear fashion, typically using steps. This method leaves something to be desired if you are trying to read a small target in a big seaway.

The other approach, typical on larger radars is to use what is referred to as a full log I.F. This approach uses a logarithmic sampling of the return echoes to try and find an echo with a defined amount of repeatability. That repeatability indicates a target that is relatively fixed, as opposed to a wave return that is constantly changing. The radar then shows you this repeated target and reduces the returns from the sea clutter.

You typically have to spend $600 to $800 more for a radar with this capability, as it costs more to build. However, if you are serious about extending the usefulness of your radar operations, this is a wise investment. If you have to make a budget choice, there are a lot of other areas in which I'd suggest reducing your investment to free up funds for this feature.

Watertight Integrity

Many of the new sets are partially sealed and somewhat resistant to spray. By using a long set of cables these radars can be temporarily set up under the dodger, perhaps with a large plastic cover, just in case!

However, just because the manufacturer says their unit is watertight doesn't necessarily mean it is. Have a careful look at the set. Note how the front controls are installed. If a membrane pad is used, that's a good sign. Rotating knobs will need O-ring seals. The weak points are typically at the back of the set. Note how the power, interface, and radome cables all connect. How is this made watertight? Usually, the most you get is a rubber boot. It might deflect some spray, but a real dunking? Hardly.

Features

There are all sorts of software features available with today's sets. Most of the bells and whistles have more of a marketing function than real use at sea. As we've already said, more important than any "feature" is the target-definition capability of the set. Beyond this, we've found the ability to put a waypoint on the screen quite helpful. Here your GPS will paint a position representing the next waypoint on the screen. This can be especially helpful when you are nearing a land mass, especially if you are not sure of the chart datum.

On our last trip through the South Pacific we frequently found our waypoints to be off by anything from a quarter of a mile to two miles from what the chart showed. The waypoint on the radar screen makes this easy to pick up (and log for future use).

You'll want to be certain that the radar and GPS are compatible. It may even take awhile to get units from the same manufacturer to talk to each other.

The ability to off-center the display is also valuable. We'll typically leave the set on 6-mile range with most of the screen image looking forward, so we get a 6-mile scale, but see forward 10 miles and aft, just 2.

Most radars will display data from other instruments, such as depthfinders, speed and wind. In most cases I can't see where this has much value. On the other hand, the ability to place the cursor over a point of land and read out the latitude and longitude really comes in handy.

Proximity Alarms

Of all the features added to radar, proximity alarms are the best. These allow you to keep watch on a sector or totally around the boat. This can be a valuable navigation tool, helps in watch-standing, and is useful as a weather alert, especially with squalls at night.

There are all sorts of proximity alarms. To be totally useful they should have the ability to function in a variety of ways. The inner and outer ring should be adjustable so that you can easily define the closest and further point from the boat that should be watched.

Next, it is essential to be able to adjust the intensity of the target that will set off an alarm. This way you can reduce the false alarms from seaclutter or a small rainsquall, while preserving the ability to see the larger squalls and harder targets.

You should be able to tell the alarm to guard only a sector — that is, a small angle rather than a complete circle.

Many modern sets allow you to set a time interval during which the radar is asleep, then awakes and makes several sweeps with the alarm on, then goes back to sleep if no target is detected. This is especially helpful as an anchor-watch alarm where the noise and power consumption of the antennae can be a bit much to bear.

Finally, check out just how easy the proximity alarm controls are to operate. Some sets make these easy to use; on others they are so complex and difficult to use that you will tend not to use the alarm.

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LCD Radars

Before leaving the section on radar we need to discuss the new LCD models. By reducing size, power, and cost they have enlarged the market to include small powerboats. This increase in market reduces costs so that really low-priced radars are now available in the LCD style. They have several advantages. First, the displays are typically more water-resistant than raster-scan units. They are also a lot smaller and lighter and take less power (about half) to operate.

The LCD screens have fewer pixels, so the letters and range rings are more blocky looking than you will find with a raster scan set. However, the pixel size is smaller than the target the radar is seeing so that your ability to interpret the image is not compromised.

The sets have small antennae and lower power output. They will give you good images in good conditions. But in rain or sea clutter they have far less ability to pick out targets than the larger sets.

If you are considering an LCD-based radar, check out screen viewing angles and how they work in a variety of conditions. Some models are very weak when viewed from other than straight on.

The smaller sets' antennae are so small that typical target discrimination is in the 7-degree range. This means that smaller targets may merge together with large targets, and larger targets may give you false echoes that are difficult to interpret.

None of this is to say that you should not use a small radar. But you must be alert to the fact that what you see may not in fact be what's out there lurking. And, in any sort of adverse conditions, you are going to have a difficult time seeing most targets. This means ships will be masked by squalls and medium-sized vessels lost in seaclutter.

Power Consumption

Power consumption with radar seems to vary little between large and small sets. Most sets seem to consume between 40 and 50 watts. The big Furuno on *Beowulf* only uses 60 watts.

The issue is a function of power management. If you are going to run the radar all night long on watch, it will substantially increase total power consumption for the day. Even a small set running for the 10 hours between dusk and dawn will consume 40 amps; that's probably more than the autopilot.

If you don't have a trolling generator, the radar could add significantly to your daily engine running time.

On the other hand, it doesn't make sense to buy a radar if you don't want to generate the power for its use. The acquisition of the radar needs to be looked at in a broader context, one that includes the DC-power-generating capacity of your boat.

Furuno make a a series of small LCD radars with surprisingly good target definition for such small screens. They are fine for watchkeeping offshore, when you are looking for large targets, and for finding a land mass. The top photo is a model 1621 while the lower is the larger 841.

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Monitor Location

Ideally the radar will be located where you stand watch at sea. If there's a pilothouse or hard dodger, you can view the radar from on deck as well as from below. However, a cloth dodger in inclement weather will make it difficult to keep the monitor (PPI) dry.

Most yachts have a favorite spot below where long watches at sea are stood, with a trip topside being the norm every ten to fifteen minutes. In this case the PPI would be mounted below, where it is easy to view and operate.

There are some conditions, working into a harbor at night or in fog, in which you will want the radar PPI on deck. In this case, if there's some slack in the cable, the PPI can be brought up onto a cockpit seat or on top of the companionway hatch.

Radars are typically mounted below on small yachts where they are protected from the elements. In difficult piloting conditions, however, you will want to be on deck and be able to see the radar at the same time. This can usually be accomplished by having an extra 10 feet (3 m) or so of cable, enough to allow you to get the radar onto the companionway hatch.

A very clever system for using radar inside and outside. A slotted bracket is fastened to the deck. A rotating trunnion slides fore-and-aft along the bracket. Rotated toward the inside and run forward on the slot, the radar is easily visible from the interior (galley, saloon, and navigation area). Run the radar aft, rotate it and you have a clear view of the screen through a port into the cockpit.

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What To Buy?

How do you know which radar has the best target definition or best service record? Take a walk down to the local commercial fishing wharf. Look at the sets the professionals are using. Chat with them about the ability of the set to pull a weak target (like another small fishing boat or buoy) out of a breaking sea or heavy rain shower.

When we were looking at radars for *Beowulf* we felt that Furuno was still the best for target definition and discrimination. We purchased a model 1941 unit with a 4-foot (1.2m) open array antennae, 4 kW of power, and a 48-mile range.

The performance of this unit is truly sensational compared to what we've used in the past. (We used a Raytheon 41XX aboard *Sundeer.*) With the display off-centered we picked up the mountains of Nuka Hiva in the Marquesas Islands at 58 miles. We were seeing low-lying atolls in the Tuomotus at 30 to 36 miles. (The best we've ever done in the past was 24 miles.) Reef breaks were showing up at 6 miles, and the ability to pick out a small target in a seaway is easily as good as the analog radars of the old days.

On a smaller vessel you won't want to devote the weight, space, or budget to a large open array. For half the weight and cost you can get an enclosed radome-based set, which will have most if not all of the software features of the larger sets. But, of course, it will not have the range and target definition. Range is not a major issue, as this is used today more for weather analysis than navigation, and with GPS the positioning advantage is minimized. But as we've already discussed, target definition is a key issue, and there is no substitute for antenna size.

Having used small and large radars, if the electronics budget was tight I might be tempted to put the money that would go into a small radar into something else (like a backup autopilot or heavier ground tackle).

Caution

Before we leave the subject of radar, a caution is in order. A set that is not tuned properly or is used in conditions beyond its ability (i.e., in sea clutter or heavy rain) is worse than no set at all. You may be sitting there looking at a blank screen, thinking you are all alone when there is another vessel bearing down on you (or you on them).

You need to use the radar in good and bad weather, checking what you see on the screen with what you see outside, to know the strengths and weaknesses of your particular set.

And even when the set is working well, you still need to take a look around outside on a periodic basis, just in case.

LONG-RANGE POSITION FIXING

We used to talk about the advantages of Decca, Loran, or Satellite Navigators based on the old transit system. In the late 1970s we even used the Omega system. But today there is only one system that makes sense for cruising and that, as I'm sure you already know, is GPS.

The question of choosing a GPS comes down to establishing your criteria. Obviously, accuracy has to be number one. How many satellites are used and how the software sequences them has a big impact on accuracy. Still, even the worst GPS is probably going to be as good as or better than a lot of charts you are using.

Ease of use of the different software features is also high on our list. There's a big difference here between sets. I expect a GPS to be intuitive in nature. If I have to refer more than once or twice to the manual, I am going to look for something different.

Another critical feature for us is a man-overboard-button (MOB). When you hit this, a waypoint is established and the range and bearing back to that waypoint is continuously displayed. For this to be of maximum use, it is critical that a clearly labeled button be dedicated, requiring a single push to activate. Some sets require two or three steps to initiate the MOB mode. This is too much to deal with in an emergency situation.

Finally, the display is a critical element for us. (The older you are, the more important this is going to be.) I want to be able to easily read the display from a distance, hopefully without my glasses on.

Does a graphic course display make sense? If it comes in the basic price and other features are up to par, why not? But if it is an extra, I can't really see the value.

Do you want a fixed or portable system, or both? If budget is an issue, the portables seem to work fine. We took a Garmin 45 unit with us on *Beowulf*'s delivery trip to New Zealand, and it usually agreed to within two decimal places with the larger Furuno 70 Mk11 system. With portables, the one issue you need to watch is antennae obstruction. They typically like to be outside. In some cases even a dodger will interfere with reception.

There are a number of ways to tell you've crossed the equator. One is to drag out the sextant and check the sun or do a round of stars.

Another is to check the direction of rotation of the water in the head as you work the pump handle.

If you are north of the equator it will turn clockwise. On the south side of the equator it will spin counter-clockwise.

Or, you can look at the GPS, but that is not nearly as much fun.

When you have conclusively determined that the equator has indeed been crossed, the real excitement begins.

That is when King Neptune comes aboard and initiates all of the crew who have not as yet become "shellbacks."

Kristin Sandvik in this photo does not know what is in store for her during her initiation! (Sarah Dashew photos)

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COMMUNICATIONS

The subject of communication gear is one of never-ending debate. There's the school of thought that one should be cut off from outside news and from any sources of help. Self-sufficiency, after all, doesn't include getting on the radio and yelling for assistance.

However, good communication gear can make life more interesting, provide valuable data to assist in making plans for the future, and allow you to stay in touch with loved ones. And in a real emergency, long-distance radio gear can make a tremendous difference. Our own leanings, gradually acquired, are toward this last argument. The longer we've cruised, the more complete our inventory of radio gear has become.

Keeping Up With Technology

Communications technology is literally exploding with options. While SSB, ham, and VHF will (probably) always be with us, new types of electronic data transmission — not to mention cellular phones with world-wide capabilities — are not far off.

It's almost certain that whatever you buy today will be obsolete in a short period of time.

VHF

VHF is what people usually look at first. In the United States as well as many other countries, this must be installed before a single-sideband radio is fitted. A Very High Frequency (VHF) radio is good only for short distances: line of sight plus a hair. At best, if your antenna is at the masthead and the receiving antenna on shore is on a hill, you might get 60 to 100 miles of range (Although on one occasion we were about 400 miles offshore and chatting with a ship on channel 16 when the U.S. Coast Guard in Long Beach, California, came on the radio and advised us to move to a different channel!). More normal is 30 miles. Two yachts talking to each other are restricted to perhaps 20 miles if both antennas are 50 feet (15.3 m) off the water.

Intermezzo didn't carry VHF gear when we started cruising. I couldn't see the need for it where we were going. By the time we had reached New Zealand, I was ready for a set, but not for the usual reasons.

It is frequently difficult to get a ship to come up on the VHF. This sign is a simple way of getting your message across!

Crossing the Tasman Sea we twice had scares when large ships came by to take a look at us. The trouble was that we didn't know if they saw us and were taking a look, or if they didn't see us and were about to run us down. From the New Zealand Marine Control I learned that New Zealand and Australian shipping is required to investigate any small yachts they see and report their position to the proper authorities. It made us feel good knowing somebody cared, but that didn't change the fact that on two occasions we had been scared out of our wits by what we thought was imminent collision. To rectify the situation, we bought a used VHF. Equipped with channels 6, 12, 13, 16, 28, and 68, it served its purpose. On virtually every passage thereafter, we contacted all ships, usually when they first became visible, to advise them of our position, get an update on the weather, and have a nice chat.

You'll want to be sure your set has the ability to switch between U.S. and international channels. Also, channel-scanning features are nice when you want to keep watch on several frequencies in use in your area.

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Portable VHF

A portable VHF can make sense in several contexts. If you're on deck and want to chat without going below, a portable is a real help. When one of the crew takes the dink ashore or when you take the crew ashore and they need to call you to come and get them, it is of real value.

Also, a portable VHF can be of real help in the abandon-ship bag for contacting ships or planes seen on the horizon.

Because of this latter usage, my feeling is the best all-around portable is that which is powered by flashlight batteries. This way you can have a bundle of batteries vacuum packed, sitting in the abandon-ship bag.

Single Sideband

I used to think SSB was pretty much useless for cruising. However, today many more yachts carry it than before, so it has become a valuable boat-to-boat communication tool. You can find a lot of cruiser "nets," as well as shore-based facilities that still communicate via SSB. And, of course, it helps with weather.

Making phone patches, however, is still extremely expensive with SSB gear, typically costing about US$5 per minute for the AT&T operators. From long distances, unless band conditions are really good, the automated answering systems of the AT&T operators are unlikely to hear you calling.

AT&T Direct

AT&T is providing a new automated service. Basically, you purchase a modem with an AT&T handset which is then connected to your SSB. To place a call, you pick a channel on the SSB, dial the handset, and if all works right, you are automatically connected to your party. You can engage a scrambler once the call is in progress so you have a level of privacy not available with normal SSB or ham. Of course, this assumes there is a channel available, and that propagation conditions are conducive to your connection.

The price is much less: US$3.50 per minute as opposed to US$15 for the first 3 minutes and US$5 thereafter. So the cost is not that far out of reach, as long as you keep those calls short.

However, the two boats we met in the South Pacific during 1995 with these modems aboard were not able to make their connections automatically. Closer to home, some friends in the electronics business report a more favorable outcome.

Ham Radio

Amateur radio has been around since man started using the ether to communicate. Today's sets are a marvel of power and function. Fully transistorized and pretuned amateur transceivers are available at higher power ratings than regular marine communications gear for about a third less than marine SSBs.

Ham gear has a tremendous advantage over marine SSB: there are literally thousands of hams around the world anxious to talk with their seagoing counterparts.

From a safety standpoint, in our opinion ham gear is by far the best. Maritime "nets," or groups of amateurs, exist all over the world (although there are some folks who will argue that an automatic marine SSB is safer). Land and sea-based, the members of these nets trade information and keep track of the positions of voyagers as they travel. Land-based hams can get detailed weather synopses from the local meteorological bureau covering the region in which you're traveling. If a medical problem occurs aboard, a specialist in the area can be brought to the phone in a matter of minutes.

At the time of our first crossing of the Tasman Sea, our friends, the Marriotts, aboard their 44-foot (13.4m) steel ketch, *Makaretu*, found out how valuable the ham network is. Belinda, their 1-year-old daughter, developed mouth ulcers and was unable to eat. Via the Pacific Maritime Mobile Net, they were "patched" into a specialist in children's mouth diseases in Honolulu, Hawaii. He discussed the problem with them, reviewed their on-board medical supplies, and advised temporary treatment. Four days later, when they made port in Opua, New Zealand, a doctor was on hand to treat Belinda; all courtesy of ham radio.

Then there was the time we were leaving Suwarrow Atoll in the northern Cook Islands. We hadn't decided whether to go to Tonga directly or via American Samoa. We had been out 9 months and needed to reprovision. If we went direct to Tonga, some 1,100 miles to the west, the reprovisioning would have had to be done in Suva, Fiji. On the ham radio we talked with yachts in Suva. Comparing prices and availability of the stores we needed, we found that American Samoa at that time was the cheapest place in the Pacific to reprovision. The money we saved by having that knowledge would have paid for the radio we were using.

At sea, in our annual migrations from one cruising ground to another, we've found that one of the high points each day is roll call. It's a chance to catch up on gossip, trade sea stories, and check on the vagaries of weather and sea state with friends on other yachts who are heading the same way. On long passages this becomes a real morale booster. It's always good to know someone else is suffering with you, or that the weather is better a few hundred miles ahead. Equally important is the intelligence gained on where to go and what to see.

The final benefit of amateur radio is the contact it provides with home. I'm sure this was a major reason we were able to enjoy ourselves for so long away from our family in the states during our circumnavigation. We were able to talk with them on a weekly basis via "phone patches" with ham friends ashore.

The licensing procedure for getting an amateur licence in most countries is not difficult. You have to learn Morse code (useful anyway for copying weather broadcasts) and a modest amount of theory. Anyone can do it, given a few months of study time. There are literally thousands of ham clubs all over the world that run classes to assist the neophyte. Once you get a U.S. license or a license from a country that has what is known as a third party agreement with other countries, it's possible to have a shoreside amateur plug you directly into telephone lines. In effect, you can talk via his phone, and at his phone rates. If it's a local call for the ham, that's the only cost.

Combination Sets

There are a number of combination ham/SSB sets on the market. These allow you to key in desired ham frequencies using a touch pad. They are not as convenient as a pure ham set but do kill two birds with one set, so to speak. When we equipped *Beowulf* we tried out an SGC combi-

The SGC 2000 is a cruiser's dream radio. It has both ham and SSB capability, can be used for telex and e-mail, and connects easily to a weatherfax decoder. The VFO knot is very helpful for working ham contacts and there are 100 user-programmable channels. We've used an earlier model (without the VFO knob) and found it to be a marvelous piece of gear.

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SGC now makes this digital signal processor which can be added to any SSB or ham rig. It uses a computer algorithm, called adaptive signal processing, and spectral noise subtraction to filter out the audio you want to hear from the background. We have not yet used one of these, but have been told they work really well.

nation set and found it quite satisfactory. SGC now makes a combination set with a VFO frequency dial that is much easier to use on the ham bands.

SSB/Ham Features

The features you'll want to check out will be the same for ham and SSB. Chief amongst these is the frequency memory capacity. Will you be using the receiver for weatherfaxes? If so, you'll want at least 100 simplex memory channels.

Next is the ability of the radio to scan banks of channels, the number of channels per bank, and the number of banks. Again, the primary importance is for weatherfaxes. It is likely that at any given time you'll want at least three stations in memory (each in its own bank) with four or five frequencies per bank.

Then you'll be adding in your favorite Voice of America and BBC stations to the list, along with other countries in which you have an interest. Before you know it, that 100-frequency memory will be used up.

Speech compressors increase your audio signal when band conditions are poor. The filtering capability of the radio is also important. This will help you deal with on-board noise, as well as that which is encountered on the air waves.

Finally, the built-in metering can affect the usability of the set. Ideally, the rig you choose will be able to measure forward power as well as reflected power (or standing-wave ratio, SWR). This is the best means of checking on how good a job your antenna is doing.

Telex

Some radios come equipped ready for telex reception and transmission. It's a nice ability to have aboard and easy to use with a portable computer.

You type a message on your PC, then via a modem send it to the radio, which in turn sends it to a shore-based station. The shore-based station then forwards the message in telex, fax, or e-mail format.

The Pin Oak modem connects between your SSB set and your on-board computer. This model is theoretically capable of deciphering signals so weak that they are below the range of human hearing.

Of course you still have to contact and connect with the shore-side station. This is typically easier than with voice, as telex will go through when voice can't be heard. In fact, it is so easy that it is usually done via software rather than using an operator. With telex you can also receive messages relayed to you via the shore station.

Broadcasting telex requires long periods of relatively

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high-powered activity from your SSB. As a result they need to be of robust construction if they are used for this frequently, with lots of fresh air available to cool the unit.

SGC makes a telex kit for their SSB/ham radios, in essence a fan assembly to pull cool air through the chassis.

SSB Digital-Data Transfer

There are several new providers of data-transfer service entering the market. They sell you a specialized modem board for your computer that can be used together with their software to send digital data at fairly high rates of speed. The most efficient use of this service is to e-mail your correspondents and/or download e-mail which has been sent to you.

The technique they employ is based on a new data-transmission technology called “Clover.” Coupled with sophisticated error-correction techniques, this allows faster transmission of data between you and the shore station.

This also makes possible two way digital communications when band conditions would otherwise be unusable for voice or even Telex type service.

As a result, the cost of message is less than conventional telex services. Because this field is so competitive and developing so rapidly, you will want to keep an eye on the service providers for pricing and service data.

Pin Oak Digital in Gladstone, New Jersey, is one of the pioneers of this service. We’ve talked with several users of the service and they report good results. Cost for this service at present is 95 cents for 1,000 bytes of data, (about 200 words). Keep an eye out for new services in this field.

A competitor in this field is Globe Wireless. They have relay stations around the world, so in theory you might be better off using them from the far reaches. However, their costs are significantly higher than Pin Oak (at present).

Both require you to purchase a modem which goes between your radio and a portable computer. These services also require accurate frequency modulation from the radio. Some older SSB’s and/or ham rigs may not be up to this task, unless modified with a more accurate frequency control.

Finally, the usage of the software that goes with these systems takes some getting used to. Unless you are computer literate you will want to have a dealer (or user) that is familiar with the system walk you through it. This gear is definitely not what you want to add in the last minute before your shove off.

Ham E-mail

Using similar technology you can take advantage of the world-wide ham AMTOR (Amateur Teletype Over Radio) service. You start out with an e-mail address tied to a ham shore-based station. Your message is sent out and picked up by one of the world-wide ham stations that automatically store and then forward your message on to its shore-based address. The addressee (a ham) in turn forwards the message to whomever it is addressed via telephone, fax or e-mail.

Messages are received in a similar manner. Your e-mail address is tied to a shore-based computer that stores messages. To retrieve messages, you simply log on — directly, when conditions permit, or via a repeater station— and pick up the messages on the computer.

The right way to bring a hot wire up the backstay and attach it above the insulator. This reduces or eliminates signal loss due to impedance.

SGC is one of a number of companies that make automatic tuners. These take note of the frequency on which you are broadcasting along with the impedance of the antenna, and create a "match" between the antenna and transmitter. The big advantage in this system is that the tuner can be mounted at the *base* of the antenna, remote from the transmitter. This is much more efficient than a manual unit mounted near the radio (and a long way from the antenna base).

The system adds a couple of hundred dollars to your radio cost for the modem, and, of course, you need to have a PC aboard. Learning to use the system is pretty straightforward. If you've mastered amateur radio, it shouldn't take more than a couple of hours to get the hang of this next step.

The real issue is the shoreside stations through which you must connect. There are a number of stations around the world that are pretty much devoted to ham e-mail. To find out more about frequencies and locations, check the internet and/or the worldwide ham directory.

THE ANTENNA

Regardless of which type of radio you choose or what service you use, the most important element in the radio system is the antenna. This is the means of radiating the power of the transmitter to the outside world, and of receiving what's coming back through the ether.

The antenna makes far more difference in your ability to hear or be heard than any other element in the radio system. The difference between an inefficient whip, for example, and a dipole antenna can be as high as 10 or more to 1! If two boats were sitting in the same anchorage, and one had a 1,000-watt radio with a short whip and the other a 100-watt radio with a dipole, the fellow with the 100-watt radio would be heard better than the other boat with ten times the power.

Long Wires

The simplest antenna for a boat is an insulated backstay (i.e., a long wire antenna). This is an "unbalanced" system, and as such requires what is called a counterpoise or radio-frequency (RF) ground plane. (More about this later.)

The backstay will be broken in two points and insulators installed. The top insulator is usually 4 or 5 feet (1.2 or 1.5 m) from the masthead, so none of the active antenna wire is near any grounded metal — i.e., the mast. At the bottom the insulator is usually just above the turnbuckle or backstay adjuster.

You'll want to insulate the bottom of the backstay with plastic, so if you broadcast while someone is holding on, they won't be shocked.

It is important to keep the feed wire that attaches to the backstay at least 2 inches (50.8 mm) away from the backstay adjuster. Otherwise signal will be lost via attentuation to this part of the boat.

Long wires can also be made from other shrouds. Sometimes an intermediate shroud which does not pass over a spreader end will be used. On our ketches we tend to use the mizzen headstays as long wires. Usually one is wired to the weatherfax and the other to the SSB or ham rig.

Whips

A whip antenna can be anywhere from a couple of feet (0.6 m) to 30 feet (9.3 m) long. The long ones can be as efficient as a backstay, without the need to add insulators to part of your standing.

Some of the whips are quite sophisticated and include electrical "traps" to fool the radio into thinking the antenna is tuned to various frequencies. There is frequently a choice of where the

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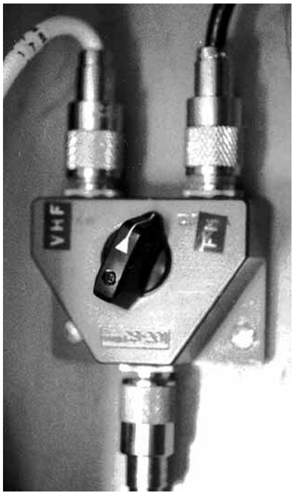
This is the wrong way (left) to run an antenna wire up the backstay!. The turnbuckle is grounded to the rest of the rig. Radio waves leaving the white antenna wire create a short via impedance between the antenna and turnbuckle. As much as 50 percent or more of the SSB or ham signal will be lost in this situation.



A simple coax switch enables you to change back and forth between antennae. We use them to share antennae between the ham radio and fax and between the VHF and FM.

antenna will be most efficient. For offshore work, the higher frequencies are where you want the power. Frequencies of 13 megs and up for SSB and 14 and 21 megs for ham.

There's a ham unit called an "Outbacker" which has been very successful on the higher frequencies.

Most tuned whip antennas do not require the use of a tuner between the antenna and transmitter.

Tuners

Whips and long wires typically need some form of a tuner to fool the radio waves into thinking the antenna is something that's really not. These can be as simple as a small black box with a couple of manually adjusted knobs. Before starting to broadcast, you tune the radio (at low power) by sending out a signal, adjusting the tuner, and watching the SWR meter. At some point the SWR will drop to a minimum figure, hopefully below 1.75 to 1, and you are ready to broadcast. Or you can go with an automatic tuner. Most radio manufacturers today offer an automatic tuner that senses the SWR and quickly adjusts to the best settings.

When you are wiring your tuner, keep in mind that the radio energy being transmitted down the coaxial cable from transmitter to tuner does not radiate (and thereby lose power) until it exits the tuner. Once it leaves the tuner, however, it is trying to make the world hear. So it is best if the tuner is as close to the base of the antenna as possible.

Ground Plane

Equally important to good transmission is a proper ground plane.

Long wires and whips are *vertically polarized*, which means that without a ground plane the radio waves leaving the antenna go more or less straight up. When the radio waves hit the ionosphere they bounce off, creating the "skip" that allows high-frequency transmissions to travel so far.

The problem is that a vertically polarized antenna has a poor skip angle. This is where the ground plane comes in. A good ground plane helps tip the radio waves so they bounce at a better angle, allowing them to cover more distance.

Ideally, a ground plane would be about 100 square feet (9.3 square meters) in area, with the antenna centered in the middle — not too practical on most boats. The next best thing is to take 2-inch-wide (50.8mm) copper strapping and lay it under the deck, radiating from the base of the antenna or coupler. It helps to tie in the winches, genoa tracks, lifeline stanchions, the lifelines themselves, and any other metal attached to the deck. This can be augmented by the ship's machinery, fuel and water tanks, keel (via the keelbolts), and through-hull fittings.

If you're having a fiberglass yacht built, ask to have the ground laminated into the deck and/or hull near the antenna coupler. It isn't necessary for an RF ground to be in contact with water, and the laminated screen works really well.

Some manufacturers say that coupling the ground to the lifeline stanchions and wires is sufficient, but our experience is that signal strength really drops if you don't do a correct job. We've found that if a proper RF ground isn't available, a second, albeit somewhat less efficient, RF ground can be made by trailing a 15-foot piece of braided battery cable from the base of the whip in the water when the radio is in use. (Note that the cable should be braided to present the greatest surface area.)

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Grounding Metal Hulls

One of the problems with metal hulls, especially aluminum, is maintaining the electrical isolation of the hull from the DC power system when tying in an RF antenna ground. If *capacitors* are installed between the antenna (or electronic chassis for that matter) and the hull, these will allow the RF ground to complete, but isolate the hull from any stray DC current.

The process is somewhat trial-and-error, using various values of capacitors until the DC ground is broken but the RF ground is maintained. We've found that putting four capacitors in parallel, each with a value of about 0.4 of one microfarad at 400 volts, works well for us.

Dipole Antennas

Other forms of antenna are available that are infinitely more efficient than whips or long wires. The most basic of these *balanced* antennas is called a half-wave dipole. It will deliver eight times the power of a long wire and hear eight times better as well. What is this marvelous piece of gear? Nothing more than a two-piece antenna fed in the center with coaxial cable. They're easy to make and easier yet to install. Since it's a balanced antenna, no ground plane is required.

Most cruisers eventually end up with a dipole, if not permanently rigged, at least for use in port. The problem with dipole antennas, however, is their length. If you're using ham gear, 14,300 kilocycles is the most popular frequency, and this requires a 32-foot (9.8m) antenna. On *Intermezzo* we just had room to permanently rig such an antenna between the main and mizzen mastheads. Or you can hoist the center of the dipole to the lower spreader and stretch out the ends fore and aft.

Dipoles do have a disadvantage in that they're horizontally polarized — that is, they're somewhat directional. When you're transmitting or listening at right angles to the antenna you're at maximum efficiency. But if the station being worked is in a direction off the end of the dipole, there will be only a slight gain over a long wire.

A dipole can be made in an hour for less than $10. The instructions are found in any radio manual or can be obtained at your local ham-radio store.

There's a slightly more advanced form of antenna called a "trap dipole." These have electrical "traps" worked in so that the antennae will resonate on a series of frequencies. If you're not really into the ham game, it's best to buy one of these.

Propagation

As we've already discussed, the SSB sends out its signal at an angle to the earths plane, heading it up towards the ionosphere. The angle is a function of antenna design and ground plane and varies substantially from installation to installation. When the SSB signal hits the ionosphere it is bounced back towards the earth, whence it is again deflected skyward and so on.

How efficient this process is depends on how strong the ionosphere is, which in turn is a function of flares originating on the sun's surface. Your signal is also affected by the time of day where you are located, and where the recipient of your signal is located.

As you might have guessed, there are a number of software programs on the market which can help you. You input your location, where you are trying to reach, a solar-flare index (which you can get from WWV), and the time of day. The program will advise the best frequency to use and perhaps a better time of day to try.

SHORT-WAVE BROADCAST FREQUENCIES	
4,750 - 5,060 (4,915)	5 MHz / 60-meter band
5,950 - 6,200 (5,975)	6 MHz / 49-meter band
7,100 - 7,300 (7,435)	7 MHz / 41-meter band
9,500 - 9,905 (9,575)	9 MHz / 31-meter band
11,650 - 12,050	11 MHz / 25-meter band
13,600 - 13,800	13 MHz / 22-meter band
15,100 - 15,600	15 MHz / 19-meter band
17,550 - 17,900	17 MHz / 16-meter band
21,450 - 21,850	21 MHz / 13-meter band
27,125	Citizens Band Channel

One of the best ways we know of to make the time pass on watch is by listening to short-wave broadcasts from around the world. With the British Broadcasting System, the Voice of America, and Canadian, Cuban, Russian, French, German, and other broadcasts, you will get an interesting take on what's happening in the world.

A lot of listening takes place late at night. We find that a set of headphones makes it easier to hear the weaker broadcasts, and keeps the boat quiet so that those off watch can sleep. (Data courtesy of Gordon West)

TYPICAL FREQUENCY PROPAGATION										
SPRING AND SUMMER										
BAND Propagation (Miles)	**4 MHz**		**8 MHz**		**12 MHz**		**16 MHz**		**22 MHz**	
	Min	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**
Hours afters sunset										
1	50	250	200	1,000	500	3,500	750	6,000	1,500	7,000
2	100	600	250	1,500	500	3,500	750	6,000		
3	100	600	250	2,000	500	3,500				
4	100	800	250	2,500						
5	100	1,000	250	2,500						
6	100	1,500	400	3,000						
7	100	1,500	500	3,500						
8	250	2,000	750	4,000						
9	250	2,500	750	4,000						
10	250	2,500	750	4,000						
11	100	1,000	500	2,500						
Hours after sunrise										
1	100	500	400	2,000						
2	0	100	400	2,000						
3	0	100	250	1,500						
4	0	100	250	1,500	500	1,000				
5	0	100	250	1,500	500	1,500				
6	0	100	250	1,500	500	2,500	750	4,000		
7	0	100	250	1,500	500	3,500	750	4,000	1,500	7,000
8	0	100	250	1,500	500	3,500	750	4,000	1,500	7,000
9	0	100	250	1,500	500	3,500	750	4,000	1,500	7,000
10	0	100	250	1,500	500	3,500	750	4,000	1,500	7,000
11	0	100	150	500	500	3,500	750	6,000	1,500	7,000
12	0	200	150	500	500	3,500	750	6,000	1,500	7,000
13	50	250	150	750	500	3,500	750	6,000	1,500	7,000

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TYPICAL FREQUENCY PROPAGATION

FALL AND WINTER

BAND Propagation (Miles)	4 MHz		8 MHz		12 MHz		16 MHz		22 MHz	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Hours afters sunset										
1	100	600	400	2,000	500	3,500	750	6,000	1,500	7,000
2	100	600	400	2,000	500	4,000	750	6,000		
3	100	1,000	400	2,000	500	4,000				
4	100	1,000	400	2,500	500	4,000				
5	100	1,000	400	3,000	500	4,000				
6	100	1,500	400	3,500						
7	250	2,000	400	4,000						
8	250	2,500	500	4,000						
9	500	3,000	500	4,000						
10	500	4,000	500	4,000						
11	500	3,000	750	5,000						
12	250	2,500	750	5,000						
13	250	1,500	500	2,500						
Hours after sunrise										
1	100	1,000	400	2,000						
2	100	500	400	2,000						
3	0	100	400	2,000	500	3,500	750	4,000		
4	0	100	400	2,000	500	3,500	750	4,000	1,500	3,000
5	0	100	250	1,500	500	3,500	750	4,000	1,500	4,000
6	0	100	250	1,500	500	3,500	750	4,000	1,500	5,000
7	0	100	250	1,500	500	4,000	750	5,000	1,500	6,000
8	0	100	250	1,500	500	4,000	750	5,000	1,500	7,000
9	0	100	250	1,500	500	4,000	750	6,000	1,500	7,000
10	0	100	250	1,000	500	3,500	750	6,000	1,500	7,000
11	0	250	250	1,500	500	3,500	750	6,000	1,500	7,000

SSB Frequencies

It wasn't that many years ago that we thought SSB was useless. However, today there seem to be more and more cruisers using the SSB ship to ship channels for "nets." There are also a number of shoreside stations like Herb in the Atlantic and Arnold in the South Pacific that are passing along cruiser-specific weather data on the SSB ship to ship frequencies. The data below is courey of Gordon West, who runs an excellent ham school as well as doing some consulting on cruising electronics requirements.

MARINE SINGLE SIDEBAND FREQUENCIES
(courtesy Gordon West)

FREQ. kHz	INFORMATION ABOUT THIS FREQUENCY
2,182	Marine, international distress & calling U.S. Coast Guard short-range
4,125	Ship-to-ship, 4S, short-range safety
6,215	Ship-to-ship, 6S, short-range safety
8,291	Ship-to-ship, 8S, medium-range safety
12,290	Ship-to-ship, 12S,
16,420	Ship-to-ship, 16S,
4,060	Ship-to-ship,short-range
4,051	Ship-to-ship, short-range
8,103	Ship-to-ship, short-range
3,023	Ship-to-ship, search and rescue
4,146	Ship-to-ship, 4A, short-range
4,149	Ship-to-ship, 4B, short-range
4,417	Ship-to-ship, 4C, daytime short-range
6,224	Ship-to-ship, 6A, medium-range
6,227	Ship-to-ship, 6B, medium-range
6,516	Ship-to-ship, 6D, medium-range
8,294	Ship-to-ship, 8A, long-range
8,297	Ship-to-ship, 8B, long-range
12,353	Ship-to-ship, 12A, long-range
12,356	Ship-to-ship, 12B, long-range
12,359	Ship-to-ship, 12C, Atlantic "Herb" weather reports
16,528	Ship-to-ship, 16A, very long-range days
16,531	Ship-to-ship, 16B, long-range
16,534	Ship-to-ship, 16C, very long-range

VHF Channels

The chart on the next page has the basic VHF channels in use today. Note that channel 16 is no longer for ship-to-ship communications, but is just for safety and distress calls.

To contact another ship or yacht use channel 13.

In U.S. waters, if you are cruising in range of coastal stations keep an eye on rates. There are major changes going on in the structure of the industry and it is beginning to look like local VHF channels may be better on price than cellular phones using roam service (although the cellular phone will still be more convenient).

When you are in foreign waters, inquire as to what channels are used for what purposes. We've often seen a totally different protocol than what's listed here. Also, yachty nets vary from one locality to another.

You may find in out of the way anchorages that the locals use the VHF as a prime means of communication. In such areas it is good PR to restrict your air time to what is absolutley necessary, leaving the airwaves free for the locals to conduct their business.

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VHF FREQUENCIES

CHANNEL	CHANNEL USAGE
1A	Port operations and commercial
5A	Port operations
6	Intership safety
7A	Commercial
8	Commercial (ship-to-ship only)
9	Commercial and non-commercial
10	Commercial
11	Commercial
12	Port operations (traffiic advisories, including VTS in some ports
13	Navigational (ship-to-ship), also used at locks and bridges
14	Port operations (traffic advisories, including VTS in some ports
16	Distress, saftey
17	State or local government control
18A	Commercial
19A	Commercial
20	Port operations (traffiic advisories)
22A	Coast Guard Liaison
24	Public correspondence (ship-to-coast)
25	Public correspondence (ship-to-coast)
26	Public correspondence (ship-to-coast)
27	Public correspondence (ship-to-coast)
28	Public correspondence (ship-to-coast)
63A	VTS New Orleans
65A	Port operations (traffic advisories)
66A	Port operations (traffic advisories)
67	Commercial (ship-to-ship only) (used in New Orleans VTS for ship-to-ship navigational purposes)
68	Non-commercial
69	Non-commercial

Ham Nets

One of the best reasons to have a ham radio is so that you can check in with the various nets around the world. These provide a clearing house for data, usually have someone who will run phone patches for you, and are the central meeting place for sea-going hams.

Even if you're not yet cruising, just listen to the nets. Follow the various conversations that take place among folks who meet on the net, and you will find a wealth of data. You'll hear boats crossing just about every body of water imaginable, you'll get a feel for weather patterns, performance, and the bests locations for anchoring, you'll learn about finding a mechanic, or getting a sail repaired.

We are indebted to Gordon West for the next three pages of lists.

0030	3.923	Tar Heel Emerg Net	Daily	N/Car
0100+	3.952	West Pub Serv Net	Daily	W/C-Baja
0100	3.935	Gulf Coast Hurr Net	Daily	C/G USA
0100**	21.407	Pac-Ind Ocean Net	Daily	Pac-Ind Oc
0130	3.758	B/C Pub Serv Net	Daily	B/C Canada
0130>0300+	28.313	10 Meter M/M Net	Daily	E/Pac-Hawaii
0145	3.908	Beaver State Net	Daily	Oregon
0200+	21.402	Gary's Happy Hour Net (M/M)	M-F	S/WPacific/Baja
0200	14.334	Brazil/East US TFC Net	Daily	E/C/ATL
0200	3.932	Great Lakes Emerg/TFC	Daily	G/L
0200/0100+	7.290	Hawaii PM Net	Daily	Hawaii
0220+	14.300	John's Weather Net	MTTHF	S Pac/Norfolk Isl
0230	3.905	Calif TFC Net	Daily	Calif
0300/0200	3.980	Oregon Emerg Net	Daily	Oregon
0330/0230+	3.992	Ariz Traffic Net	Daily	Ariz/Baja
0200>0400+	14.300/313	Seafarers Net (M/M)	Daily	Pac/W Coast
0300+	14.106	Traveler's Net	Daily	Aust/Ind Oc
0300**	7.090	Mexican Emerg Net	Daily	Sonora
0300	3.960	Columbia Basin Net	Daily	Washington
0330**	14.040	E/C M/M CW Net		E/Coast
0400	3.917	Cal/Pac Oper Net	T-S	West Coast
0400+	14.115	Canadian DDD Net (M/M)	Daily	Pacific
0400+	14.318	Arnolds Net	Daily	So Pac
0400/0300**	14.075	Pac CW Traffic Net	MWF/TTH	Pacific
0500/0400+	14.314	Pac Mar Net - Warm Up	Daily	Pacific
0500	21.200	UK/NZ/African Net	Daily	Pac/Ind Oc
0500	14.280	USA/Australia TFC Net		Pacific
0530/0430+	14.314	Pacific Maritime Net	Daily	Pacific
0620	3.944	Traffic Handlers Net	Daily	Oregon
0630	14.180	Pitcairn Net	Mon	So Pac
0630	14.316/105	So African Mar Net	Daily	Atl/Ind Oc
0630	14.313	International M/M Net		Atl/Med/Car

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0700	14.265	Pacific Island Net		Pacific-W/Pac
0700	14.310	Guam Area Net	Daily	West Pac
0715+	3.820	Bay of Islands Net	Daily	Aus/NZ/So Pac
0800	2.780?	Austraila Traffic Net		Aust/So Pac
0800>0830+	14.315	Pac Inter Island Net	Daily	So Pac/Sea
0800+	14.303	UK Maritime Net		Pac/Med
0900	14.313	Mediterranean M/M Net	Daily	Med
0900	7.080	Canary Island Net		Atl
1000	14.313	German M/M Net	Daily	Atl/Med
1000+	14.320	South China Seas Net	Daily?	S/WPac S/China Seas
1030	3.815	Caribbean WX Net	Daily	Car
1100/1000+	3.770	Mediterranean Prov WX Net	M-Sa	NE Canada
1100>1200+	7.237	Caribbean M/M Net	Daily	Car
1100+	14.300/313	Intercon Net	Daily	N/S/C Amer
1100+	14.283	Carribus TFC Net	Daily	E/C-Car
1110	3.930	Puerto Rico WX Net	Daily	PR/VI
1130	14.316/105	So African M/M Net	Daily	S Atl/Ind Oc
1130	21.325	So Atl Roundtable	Daily	S Atl/Ind Oc
1145	14.121	Missisauga Net	Daily	E Can/Atl/Car
1200**	14.040	M/M CW Net		E/C USA
1200+	14.332	YL Emergency Net	Daily?	USA
1200+	14.320	So East Asia Net	Daily	Sea/Indones/USA
1200	7.233	Rec Veh Service Net	Daily	East US
1230	7.185	Barbados Info Net	Daily	Carr
1245/1145+	7.268	E/C Waterway	Daily	E Coast/Car
1300>1330+	21.400	Trans-Atl M/M Net	Daily	N Atl/Med/Car
1300+	7.085	Central Amer. Breakfast Club	Daily	Cen.Amer.
1345	3.968	E/C Waterway Net	Daily	E/C, Car
1400	7.292	Florida Coast Net		Florida
1400+	3.968	Sonrisia Net	Daily	Baja/Cal
1500**	7.193	Alaska Net		Alaska
1430/1530+	7.294	Eabasco Net	Daily	Baja/Cal
1600/1500+	7.238	Baja Cal Mar Net	Daily	Baja/Cal
1600>2200+	14.300/313	Mar Mobile Serv Net	Daily	Atl/Car
1630	14.303	Swedish Mar Net	Daily	Ind Oc
1630	21.350	Pitcairn Net	Fri	So Pac
1630+	7.263	RV Service Net	M-F	Pac Coast
1630+	14.340	Cal-Hawaii Net W/U	Daily	Cal-Haw, E/Pac
1645+	14.297	Pac N/W to Baja Group	Daily	Pac N/W & Baja
1700	14.313	International M/M Net	Daily	Atl/Med/Car

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1700+	14.323	US/Canada Power Sqdn. Net	Sat	
1700+	14.340	Cal-Hawaii Net	Daily	Cal/Haw
1700+	7.240	Bejuka M/M Net	M/F	C/Amer/Panama
1730	14.115	Alaska-Pacific Net	M-F	Alaska/Pac(Sourdough)
1730+	14.115	Canadian DDD Net	M-F	Pac(Summer)
1730/1830+	14.342	Manana M/M Net-W/Up	M-Sat	W/C-E/Pac
1800/1900+	14.285	Kaffee Klatch Un-Net	MWSa	Haw/Tahiti"News"
1800/1900+	14.342	Manana M/M Net	M-Sa	W/C-E-Pac/Baja
1800+	14.303	UK Maritime Net		Atl/Med/Car
1800	14.342	Gordon on the Air		W/W
1800	7.076	So Pac Cruising Net	Daily	So Pac
1900/1800+	14.305	Confusion Net	M-F	Pac/Alaska
1900	7.255	West Pacific Net		W/Pac
1900+	7.285	Hawaii AM Net	Daily	Hawaii WX
1900+	21.390	Halo Net		N/S Amer
1700>1900+	14.280	Int Mission RA Net	M-Sa	C/S Amer/Car
1900+	14.329	Bay of Island Net	Daily	NZ S/Pac (Colin's)
1900**	3.855	Friendly Net		Hawaii
1900	3.990	Northwest Mar Net		Pac NW
2000	3.970	Noontime Net	Daily	Washington
2000+	7.095	Harry's Net	Daily	West/So Pac
2000>2200+	21.390	Inter Amer TfcNet		N/S/C Amer
2030	14.303	Swedish Mar Net	Daily	Atl Oc
2100+	14.315	Tony's Net		NZ/So Pac
2100+	14.113	Mickey Mouse Connection	Daily	So Atl/Antartica
2130	14.290	E/C Waterway Net		E/C USA
2200	3.930	West Indies SSB Net	Daily	PR/VI
2200	21.350	Pitcairn Net	Tues	So Pac
2200+	21.402	Pacific Maritime Net 15 MTR	M-F	S/W/E Pacific Baja
2200+	21.412	Mar Mobile Serv Net	M-F	S/W/E Pacific
2200	3.940	Sea Gull Net	M-S	Maine
2230	3.815	Caribbean WX Net		Car
2230	3.958	Mass/Rhode Isl Net	Daily	Mass/RI
2200>2400+	14.300/313	Intercon Net	Daily	N/S/C Amer
2310	3.930	Puerto Rico WX Net	Daily	P/R-V/I
2330	21.325	So Atl Roundtable		So Atl
2400>0200+	14.300/313	Mar Mobile Serv Net	Daily	Car/Baja/Pac
2400	14.320	Sea M/M Net	Daily	S&WPac/Sea
as needed +	14.325	Hurricane Net	A/R	Atl/Car/Pac

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SATCOM C FAX/TELEX

Another approach is to use a direct satellite link for sending faxes or telexes. On *Beowulf*, because we needed to stay in touch with business, we've used a Trimble Satcom C modem. The antenna is about the size of a medium Tupperware container and quite unobtrusive.

When in standby mode our Trimble unit consumed about 8 to 10 watts of power per hour. However, you can have your land/earth station store your messages for you to pick up when you come online so the set does not have to be on all of the time. The software is easy to use, and there are several really interesting features to this service. The first is cost. We averaged about a penny a character. The average 200 character message cost us about $4 (there's a certain amount of "overhead" associated with the beginning of a message), and we found that most of the messages we sent were in this size range.

Next, the set can be instructed to automatically download weather forecasts. As we moved across the Pacific we would receive four times a day a detailed two-page analysis of what was happening in our area. Initially this came from NOAA in the United States, and then from New Zealand Weather Met Service. And the reports are free!

Next, the set can be instructed to automatically send a location, speed, and heading message to be relayed by the earth service provider to whomever you designate. The cost for this is typically under 50 cents per message. It's an easy way to automatically tell the folks back home how you're doing.

The receiver modem has a built-in GPS terminal, offering a backup navigation device. Finally, for emergencies the modems will act as an EPIRB, giving vessel I.D. and location. You can then communicate with Inmarsat search-and-rescue coordinators via the terminal to advise them of your status.

DIGITAL E-MAIL

As we go to press Magellan, one of the portable GPS pioneers, has introduced a *handheld* satellite communications device for under $1,000!

This unit offers world wide coverage, through a constellation of low-earth orbit satellites owned by Magellan's parent company, Orbitcom. The unit has a built in keyboard, can store and retrieve data automatically, and can be operated with a portable computer if that is more convenient.

Cost per character is yet to be determined, but we've been told it will be competitive with Sat C at under a penny per character.

It will store 150 addresses and hold up to 100 messages. Message length is limited to about one page. And, the Magellan unit incorporates a GPS reciever with a full-featured trackplotter. The built-in GPS allows it to automatically insert your Lat/Lon position into your messages.

For both on-board communications and emergencies from a life raft this product offers some exciting possibilities.

SATCOM M VOICE AND DATA

The next step up in cost and size is a Satcom M terminal. This provides voice and data capacity but saddles you with one heck of a large antenna dome!

Using the M terminal is almost as easy as lifting the phone and dialing a number. It works the other way, too. The people on land can dial your terminal number and *voila*, there you are. Currently this service runs about $5 per minute.

One of the practical problems with the M terminal is that to be able to receive messages you must leave the terminal on. This takes a lot of power, and on a sailboat may not be practical.

We've spoken to several folks with M's aboard. According to them, what makes the most sense is to have both M and C receivers. Then, if someone really wants to reach you they can send a message on the C modem, alerting you to call back on the M. This keeps power consumption to a minimum.

DIGITAL CELLULAR SERVICES

Digital cellular service, with a direct uplink from phone to satellite, is coming on fast. At present there are two systems on the market that offer the use of small antennas at modest cost, typically under $1.50 a minute in North American waters, with a modest increase farther offshore. The footprint of these systems is limited to the United States, Canada, Mexico, the Caribbean, and Hawaii.

Several worldwide cellular services are supposed to be in operation by 1998. These will not require the use of specialized antennas, but will operate from what looks like your typical domestic cellular phone. Like with anything to do with electronics, things are moving so fast in this field that the longer you wait to make a choice, the better off you'll be.

The SatCom M antenna is compact enough to be functional on vessels 50 feet (13.4 m) and larger .

0183 INTERFACE

As you work through the catalogs and talk to electronics salespeople, you will hear a lot about interfacing electronics. This is accomplished via an industry standard called 0183 (although the word "standard" is really a misnomer!). Unfortunately, there are all sorts of interpretations of what constitutes the standard and how to use it.

As a result, the level of success achieved in this electronic dialogue is very much a function of how technically adept the installer is. Even with electronics from the same manufacturer there can be problems.

If you feel that an interfaced system is important, try to stay within one manufacturer's grouping of equipment. Buy this gear from an electronics outfit that will guarantee installation and dialogue, or give your money back.

ELECTRONIC CHARTING

Video plotters with electronic plotting ability are the new rage. Still in their infancy at this writing, none of the systems we've reviewed seem to deliver an acceptable level of performance for *offshore cruising* — at least not enough to justify the cost, complexity, and space taken (although for local cruising they definitely are beginning to make sense). However, the systems are now in their third generation. Sometime in the next year or two we'll see a price/performance breakthrough.

While we haven't worked with these systems, in talking to folks who have, a few issues rise to the surface. The first is having a system which is flexible in what chart formats it will read. There are a lot of different formats available, and ideally you could use charts from several sources.

Some companies digitally copy various charts, but other libraries are available direct from government organizations (such as the entire NOAA catalog or the British Admiralty inventory).

PC-based systems running off CD-ROMs look like the wave of the future to me. This way you have the ability to do a variety of things beyond navigation with your "plotter."

Speed is the ultimate criterion. How fast you zoom and scroll will become a major factor once you have gotten over the novelty of the new system. Make sure to test all the choices on the computer you are thinking of using before making a commitment. At press time, Navtrek, running under Windows 95, is supposed to have the fastest displays. However, this is bound to change.

Finally, there is the issue of paper or computer. Which way to go, or do you need both? We've had this discussion with a number of folks. It seems to come down to this. If you have a backup system (i.e., a second PC), and if you are well protected from lightning, it may make sense to carry your overall and detail charts on CD-ROM, with a good inventory of sailing directions or cruising guides and a few large-scale charts to back you up in an emergency. Then, make paper copies of the computer-chart details before each passage so if there is a problem (lightning hit, loss of power, computer failure) you have a backup means of making landfalls (with a few intermediate stops laid out for emergency).

In this context, it may make sense to look at carrying one of the inexpensive bubble-jet printers which do 11-inch x 17-inch (280mm x 432mm) prints.

WEATHERFAX

Now we are getting to a piece of gear that can pay its weight. If you can predict the weather and know which way to head (to or away from the wind), your passages will be faster and more comfortable. Wear and tear on rig and sails will be reduced. If you save one sail in three or four years of cruising, you've more than paid for the fax.

A Furuno 207 weatherfax. We've been using these units for over 10 years and have found them quite efficient at receiving charts in weak signal areas.

Before getting into the type of fax to buy, let's look at how they work. There are a variety of stations around the world broadcasting all sorts of weather, temperature, and wave data. The stations typically broadcast on four to six frequencies at once, so you have a chance to pick out the best one for reception at your location and time of day. In most cases there will be one or two times a day when reception is clear enough to get usable charts. The station broadcasts a start and stop signal that tells the fax to begin and end. If this signal is missed, you'll end up with no fax, or a huge pile of paper on the floor.

In the real cruising world, unattended operation is a benefit, as broadcast time may coincide with a trip ashore or some other activity.

Stand-Alone Faxes

Stand-alone faxes, like the Furuno 1408, have all the weatherfax frequencies built into memory. You can tell the set to refer to a given station and then

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scan for the strongest signal. This is a wonderful feature when it works. If there are strong and weak signals it will do a good job. But if all the signals are marginal or worse, it may miss the start tone. In this case you need to listen to the signal yourself and tell the reciever when to start. These sets have built-in timers so that you can program it to start and stop at different times for different stations.

During our delivery trip with *Beowulf* down to New Zealand, we were sitting in Fiji waiting for the best weather for our last leg to Bay of Islands (we wanted lots of wind!). We were picking up charts from New Zealand, Australia, Hawaii, and Rarotonga. None of the four charts agreed with each other, but at least we had the luxury of making our own mis-analysis.

Using the SSB as a Fax

An alternate approach is to get a “demodulator” and the appropriate software that allows your SSB or some other all-band receiver to pick up the signals and a PC to make the charts.

There are several pluses to this scenario. The biggest is the clarity of the image. You can get a much better chart on a computer monitor than on paper. You also have the ability to use image-enhancement software to clean up your charts. Finally, you can overlay or sequentially view charts.

But there are negatives. Typically you have to stop and start the system manually. You have to listen to the stations available and decide which is best. (This is less onerous if your SSB or all-band receiver has available memory into which you can load the frequencies. Our SGC allows memory and auto-scanning.) If you are listening to a net or radio station when it is time to pick up a chart, you need to decide which to forgo.

Which Fax?

It’s a hard choice. We’ve sat in an anchorage running our fax while a neighbor was using his SSB and computer and then compared images. His were significantly better than ours. We’ve also had people tell us that they wished they had a stand-alone unit because of the ease of operation. We’ve seen a lot of boats with weatherfaxes of both types who were unable to use them because they didn’t know how to tune in the stations.

Having looked at both sides of the equation, I think I would use the following logic to decide. First, if budget is not an issue I’d go with the stand alone unit (it will run about $1,500 or more). Next, if weather was a significant issue (i.e., high-latitude or out-of-season passages), I’d try to find the budget for a stand-alone unit. Otherwise, I’d go with the demodulator for the SSB or ham rig and then be sure I had practiced with it *before* heading offshore.

MAKING CHOICES

How do you decide which gear is best for cruising? The first consideration is budget. None of this is worth staying home to make more money in order to afford it. But if you have a few extra bucks stashed away toward electronics, here is the way we’d make our choices.

A portable GPS. For $300, it’s hard to beat. (While a sextant is a wonderful tool, it doesn’t work too well in overcast conditions.)

An inexpensive depthsounder makes sense in the same price range.

With a little more budget I’d go for a radar at around $1,500 to $1,800, and then pick up a used ham rig (like an old Atlas rig) for $200 or so.

Before spending money on a new radio, weatherfax, or anything else, we’d upgrade the radar to a more powerful model, hopefully with an open-array antenna.

If there’s still money to be spent, it would go to a more modern radio, with an all-band receiver and scanning and memory capabilities so that it could double as a fax.

Finally, we’d get a dedicated weatherfax.

COMPUTING PERFORMANCE

We've been throwing a lot of decisions your way in the last couple of sections, and you may be wondering if there isn't a more scientific way of deciding what to do than using gut feel.

Today, no self-respecting racer would consider building a new yacht, let along racing one, without some form of computer analysis. In the America's Cup, computers are the heart and soul of every challenge and defense.

Since cruising's your bag, what can all these megabytes of technology offer you? Plenty! Within the confines of most home computers there lurks the capacity to calculate all sorts of performance variables that can help you cruise more efficiently. If you go cross-eyed at the mention of a computer screen, there are a number of services that, at modest cost, will perform the chore for you.

Velocity-Prediction Programs

At the heart of all this is something called a velocity-prediction program (VPP), mentioned briefly in the electronics section. VPPs for sailing got a start some years ago when the North American Yacht Racing Union (now U.S. Sailing) and the Cruising Club of America teamed up to find a new handicap rule. Professor Jake Kerwin of the Massachusetts Institute of Technology was hired to see if a way could be found to create a computer model of what happens when you go sailing. With the aid of a graduate student, George Hazen, and thousands of lines of computer programming, they were able to come amazingly close to predicting the real world.

Reduced to its simplest factors, these programs look at your hull shape and analyze its efficiency. They then investigate the keel, rudder, propeller drag, and performance of the rig and sailplan. Throw in some factors for the vertical center of gravity, boat weight, windage, crew weight, and payload, and pretty soon the computer spits out numbers that report, for different wind strengths, traveling speed at various heel and apparent-wind angles.

By modifying the input data you can then play an infinite number of "what-if" games. This data is so valuable today that virtually every major yacht-design office in the world uses some form of VPP as a design tool.

Using the VPP

How can you use VPPs? If you're thinking about buying an inventory of new sails, VPPs can help you decide on sail size. Wondering how a new boat will react under several tons of cruising gear? VPPs will analyze its effect on speed and stability. Want to trade your fixed prop for a feathering wheel? A VPP can show you what will happen to your sailing performance as a result of the change.

While VPPs are only reasonably accurate at predicting performance between different types of yachts, they are extremely close at predicting how a single change will affect a given vessel. If the computer says you will gain 3 knots of boat speed when beating in 14 knots of wind by adding 2,000 pounds (907 kg) of lead to your keel, you can be pretty sure that this is what will happen.

If you're reading this with one hand over your wallet, it's time to relax. Thanks to the folks at U.S. Sailing, parts of this computing power are available at modest cost. If you have access to an IBM computer or compatible and are a U.S. Sailing member, for about $750 they will send you a program that will let you play "what if" games with your prop, mast and sails to your heart's delight.

In addition to their program, you will need a hull-definition file. You can obtain this from your designer or from U.S. Sailing with the designer's permission to release your file.

There are all sorts of ways this data can help with your cruising plans. One of the best ways is with sail inventory. Assume it's time to buy new headsails. Storage space is usually limited, as is budget. You want maximum performance yet good flexibility, for your sailing conditions, so with a few sails you try to cover the expected wind ranges.

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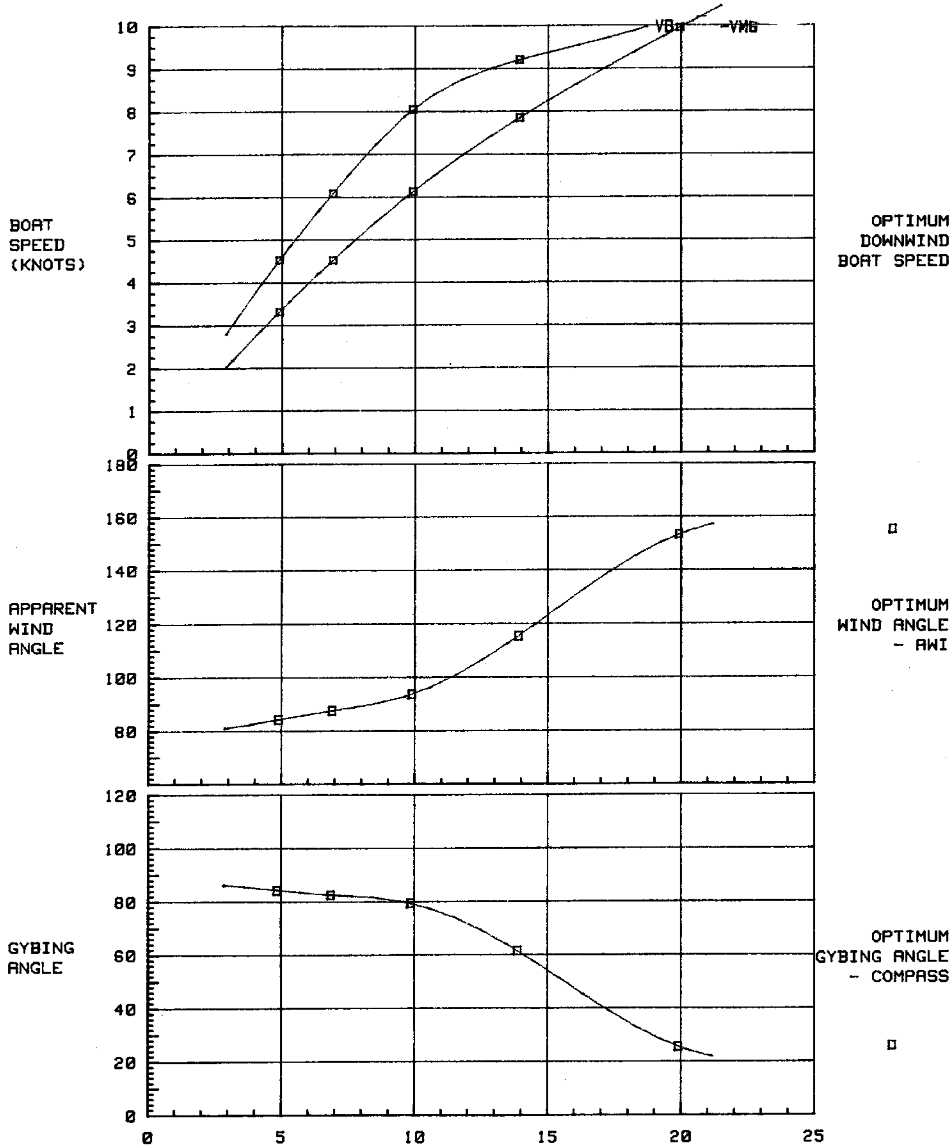

Here's where the VPPs start to pay off. The top curves give you the target boat speed for each true-wind speed velocity (if you are sailing faster, head lower; if you are sailing slower, head up). The middle curve shows optimum apparent-wind angle for any given windspeed. The lower curve is optimum jibing angle (between jibes) for a given wind strength.

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The first step is to do a VPP of your yacht, or a close approximation, with your current favorite jib and spinnaker used as a base. (Even if you don't have the hull and other data for your own yacht, you can make good use of these services by adopting a similar design to your own and computing changes on it.) You'll receive data on how fast these sails will take you in a variety of wind directions and wind strengths. You'll also get velocity made good (VMG) for up-and-downwind sailing. (VMG is the actual speed made good toward your final point. This takes into account speed through the water, leeway, and course.) On the next run, try a smaller jib. You may be surprised to find out that upwind in any sort of a breeze, the computer will show the smaller overlap to be as fast or faster than the larger sail. This is also what happens in the real world. The same is true of your downwind-sail size. You'll find that a somewhat smaller spinnaker, maybe just 85 percent of a racing sail size, will be only one or two percent slower, yet will be stronger, easier to fly, and usable into higher wind ranges.

Of course, you need to decide how much wind to optimize for. If most of your sailing is in summer on the Chesapeake or Long Island Sound, you'll tend toward bigger sails that show better speed in the light stuff. But if it's offshore work you're aiming for, you can pick computer printouts for more conservative conditions.

The key to all of this is that the computer can show the variations in firm numbers. You can then make value judgments. If that extra one or two percent is really important, go for the bigger sail. If you're more interested in a little comfort and reduced hassle, the smaller sails may be your ticket.

As you're evaluating boat speed, you can also look at factors like heel angle. The computer will heel your boat to its fastest, most efficient point regardless of comfort. You'll probably shorten down sooner than the software does, but if you see 22 degrees of heel in 14 knots of true wind with one sail, and 27 degrees with another, you know that there are 5 degrees more pain associated with the bigger sail. That may be of more interest than the boat speed!

Windage in the mast has a lot to do with upwind and reaching boat speed. If you currently have a telephone pole for a spar and are considering something more svelte, make another run with the VPP. It will predict the actual performance difference. You can look at adding to or shortening the rig at the same time.

Propellers are another good place to check performance. If you're thinking about switching to something more suitable to your cruising plans, the VPP will offer a pretty good idea of the impact on sailing performance. Changing from a fixed three-blade to a feathering prop will be a real eye-opener. Sailing performance jumps substantially. Enough to warrant the cost and hassle? That's up to you. At least now you know how much speed is involved. Maybe it's a choice between a new jib and a new prop. Why not see which change gives you the most performance boost for the buck?

These programs can also show the range of stability curve, telling how far your boat can heel before it turns turtle. The curve also indicates how stable (or preferably, unstable) the boat is when capsized. It's worth checking if you're heading offshore.

VPPs are starting to be used by the marketing guys. If you're basing a buy decision on computer-generated performance data, bear in mind that the computer output reflects its input. By fudging on weight, center of gravity, sails, or other data, even a dog can be made to look really hot. One also has to look at the input data to be sure it represents how you'll be sailing the boat. It doesn't do much good to drool over high-speed reaching performance with a 150-percent genoa when you and your cruising crew will only be able to handle a 115-percent sail.

While we're being realistic about this data, you have to realize the computer assumes smooth water, an expert helmsman, perfect sail trim, and expertly cut sails. To the degree than any of these factors are not up to snuff, your performance, *vis-a-vis* the computer, will suffer.

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Getting Your Own Data

U.S. Sailing will do VPPs on sister ships, or close approximations thereof. As of this writing they have over 600 different stock boats on file, ranging from Alberg 35s to MacGregor 65s. Or, you can arrange for a full IMS measurement certificate for your hull shape is analyzed by a special device employed by the U.S. Sailing measurer in your area. A standard "Performance Pack" costs about $150. When U.S. Sailing runs this for you they will change inputs for you (such as prop type and size, headsail overlap, gear weight, and spinnaker size).

Peter Schwenn of Velocity (tel. 301-927-9254) runs VPPs in a somewhat different manner. Your hull shape is "digitized" into the computer using a line plan of your hull, usually supplied by its designer. Peter then inputs the rig, keel, rudder, and sail data along with information on your weight and center of gravity. His output has the basic boat-speed data, performance polars (performance polars are also supplied by U.S. Sailing), and a variety of other performance curves. The performance polars and curves can be valuable in tuning your cruising boat. Tuning is important even if you're not racing. By looking at the VPP data, or the performance curves, you can gauge your own performance and sail trim. This approach is less expensive than getting an IMS certificate.

If the basic data fed into the computer is correct, and your boat speed is more than a few percent slower than the computer-predicted pace, something is wrong. Maybe sail trim is off, the bottom is dirty, or sail shape isn't optimal.

Target Boat Speed

Along with direct boat-speed comparison, there are two other bits of information from the VPPs that can help your cruising/sailing performance. The first is "target boat speed." This is the computer's estimate of the best boat speed at which to sail to windward in a given amount of wind. When you look at the upwind output and find best VMG at 6.3 knots of boat speed, that's your target. If you sail faster, you are footing too far off the wind. Sailing slower means you're pinching and need to head off. This is a very effective way to get yourself uphill with maximum efficiency.

Target Wind Angle

Target wind direction is what to look for to get the best from wind performance. Once again, go back to the VPPs and look up the apparent-wind angle at which the computer shows you making the best VMG off the wind at different wind strengths. Maybe it's 145 degrees when sailing in 10 knots of wind. Well, by keeping the apparent-wind meter at 145 degrees and setting your sails accordingly, you're going to be pretty close to the best jibing angle for a downwind passage.

ENTERTAINMENT SYSTEMS

OK, this is a highfalutin way to talk about a tape deck, CD player, or video system, but today some of this stuff tends to be sophisticated.

Music

The key factors with music is how sensitive your ear is and what you are willing to pay. There are literally hundreds of systems on the market today. Key factors are size of boat, noise level inside when at sea (if you want your music system to compete with that), how much time per day the system will be on, and what your boat's charging tolerances are.

Speakers

By far the most important ingredient in your sound system aboard are the speakers (just as in a house). You will want to use speakers that are outdoor-rated, even for inside the boat, as humidity will eventually ruin anything less. Fortunately, today there are a variety of outdoor speakers available with very good sound.

Speakers come with an "impedance" rating. This has to be matched to the amplifier and is the cause of some confusion. Basically, as long as the speaker is rated higher than the amp (for example 6-Ohm speakers and a 4-Ohm amp), you are okay. However, when the speakers have higher ratings than the amp there will be less power available to drive the speakers (i.e. 6-Ohm speakers and a 4-Ohm amp would cut output by 50 percent). You can match impedance of speakers that are rated higher than the amp, by wiring them in parellel. For example, two sets of 8-Ohm speakers in parallel look the same to the amp, as one set of 4-Ohm speakers (but don't try this with a set of sixs, as they would appear as a 3-Ohm pair).

Do you want speakers on deck as well as down below? That second set takes space and budget, but it can be really nice to have music in the cockpit. Sometimes one (or both) of the belowdecks speakers can be wired with extra-long leads and then brought into the cockpit from below.

Speakers have powerful magnets in them so you will need to keep them well clear — 4 feet (1.2 m) at least — from any compasses (steering or pilot).

Tuner/Amp

Assuming you are going with an automotive system, do you want a cassette or CD player? We've found CDs far superior to take afloat because they last indefinitely. However, if you have a remote CD changer, then a tapedeck probably makes sense in the tuner as it gives you both capabilities.

Next consider power output. Most good amps today are rated at 4 x 35 watts. However, this power is on a peak basis and on a continuous basis it is more like 10 watts per channel. A 4-channel amp makes sense if you are going to use two pairs of speakers. Otherwise, single output will get the job done for less money.

There are two classes of amps. Class "a/b" uses power in proportion to the volume. This is what you want in order to conserve power. Class "a" amps are at full power 100 percent of the time, and while they typically have a better sound quality, the power consumption is too high for use on sailboats.

CD Players

Automotive CD players are several times the cost of home units. This is due to their ability to take shock loading. We've tried home-style CD players and found that they cannot be used at sea. In fact, you should not even try them at sea, as the CD can get jammed inside in rough weather. However, there is no reason they won't work in port.

Household Systems

Several times we have used household current–based systems powered with the inverter. You can certainly get a lot more performance for the money this way. The negative is power consumption. It is going to be at least 50 percent higher than a 12V system, probably more.

If you do decide to go this route, check carefully with your inverter manufacturer to be sure it won't create interference with your music system.

Video

Today most yachts carry video gear, both to record their travels and to watch movies. The most compact way to do this is to use a combination TV/video system. These are available with dual voltage: they'll run on household current as well as 12V.

One of the issues you face is format. The U.S., Canada, Japan, and some of the Caribbean is on NTSC format. The rest of the world (except for France) is on PAL. If you want to be able to watch videos or local broadcasts in other parts of the world, get a set that handles both. These can typically be had for a couple of hundred dollars extra.

TV-screen size is always a big issue. Bigger is better for viewing, except power consumption goes up exponentially, as does bulk abnd weight. We've used 13-inch (330mm) monitors on some pretty big boats with success. If you are intrigued with big-screen viewing, look into video projectors. They are getting lighter and more efficient, with better pictures all the time.

LIGHTNING PROTECTION

Lightning is a powerful, not fully understood phenomenon of nature. While the risks of taking a hit are small, they nonetheless exist. It is important to understand that there is no way to predict the results of the hit, since characteristics vary widely, as does the magnitude of the lightning bolt.

Lightning builds up somewhat as follows: Friction within a cloud creates a stratified charge of positive and negative ions. The positive ions are usually in the upper region of the cloud, while the negatively charged ions generally reside at the bottom of the cloud.

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Because like charges repel each other (and unlike ones attract), the area immediately below the cloud typically has only a limited number of negative ions. The cloud does, however, attract a group of positive ions in the area below it (attracted by the negative charge of the cloud base). Now, air being a pretty good insulator, and all other things being equal, there would be no interaction between cloud and ground. Thus, the charge in the cloud just builds and builds. When the area of positive ions that is dragged along the ground by the cloud reaches your boat and if the charge buildup in the cloud is great enough, the cloud may shoot down some “leaders,” trying to complete the circuit between negative ions at the cloud base and positive ions around your boat. These leaders take a series of zig-zag steps as they approach the earth, looking for a ground connection.

At the same time this is coming down from the cloud the positive charge on surface of the earth is looking for a jumping-off point where it can accumulate sufficient energy to make the connection to the cloud’s leader. The leader itself does not pack much wallop, but it ionizes the air to create a more efficient path for the big charge to follow.

As the cloud-to-ground connection is made, part, but not all of the energy differential is consumed. The norm is for a series of interchanges to take place along the same path, typically three to as many as 20, all in a split second. The number of these, and the differential between the cloud and earth, determine how big a lightning hit will be.

The issue we now face is how to make the boat less attractive to a lightning discharge. Considering the fact that your mast is a good conductor, and it is by far the highest thing around, it makes a pretty inviting target. The answer lies in reducing the “potential” difference between the mast and the surrounding water. This is accomplished by electrically bonding the mast to the water.

My first exposure to the lightning problem occurred on a lake in the Ozark hills of Missouri, when I was going to college. We were out sailing in a small catamaran when a front came through, bringing with it the usual rain, hail, and lightning. We could see lightning striking the ground on either side of the lake as the rain came toward us. My initial reaction was “My God! Our mast is aluminum and higher than the surrounding scrub.” Deciding that discretion was the better part of valor, I capsized my cat and swam for it. That was *not* a smart move. I didn’t think about the conductivity of fresh water if it took a direct hit and we were in it.

At sea, anecdotal evidence indicates that properly protected, a small vessel presents little physical danger to those aboard. There’s considerable financial risk, however: a good hit can wipe out all electronic gear aboard, including clocks, alternators, radios, radars, and long-range navigation gear.

Using a Bonding System to Dissipate Static

Your aluminum mast is quite an efficient conductor of electricity. The problem lies in getting the mast connected to the water. This is typically accomplished with a heavy bonding wire (# 4 wire is good for this purpose) connected from the mast heel to the keel bolts. The outside lead ballast is a reasonably efficient ground path to the water. If you also connect the through-hull fittings and engine block (through which the prop shaft and prop are brought into play), you now have a good overall package to dissipate that static charge before it can attract a strike.

Grounding Plate

The only problem with the above grounding system is in its ability to deal with a lightning strike. If a strike does occur, the power will find a way down the boat and into the ground (the sea). It will take the most direct path possible. If your bonding wire at the bottom of the mast makes a right angle to head back for the keel bolts or to some nearby through-hull fittings, the odds are that the lightning is going to take the direct route straight through the bottom, it generally won’t take a turn. This could leave you with a large hole.

One alternative is to fit a grounding plate below the mainmast, yielding a more direct path for the lighting hit to exit. This ground plate also help with static dissipation and can be used as an RF ground for electronics.

If you do have a ground plate, be sure to keep it unpainted and clear of marine growth.

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Masthead Dissipaters

To further reduce the charge of static you can use a lightning dissipater. This resembles a bottle brush. Essentially, it's a stainless pipe with hundreds of little wires sticking out the top. Those little wires help the ions bleed off so the cloud-to-ground leader looks elsewhere to make its connection. If you have a split rig, it is recommended that you install a dissapater on each spar. This type of device has been used for years on radio towers, power-line pylons, and microwave towers.

The Cone of "Protection"

There is a theory that a cone of protection exists under your bonded mast, and that if you or your gear are inside of this cone, all is safe. However, the theory is controversial, and we've heard lots of anecdotal evidence that "side flashes" can and do occur between the main lightning strike and nearby objects. If an electrical potential exists between the main hit and nearby metal, and if your body becomes the path to equalize this potential, serious damage may occur to you.

Bond All Metal

Side flashes result during a hit when there is a different electrical charge on various parts of the boat. This can be harmful to electronics and bodies if they become the path for the electrical differential to neutralize.

To minimize the risk of side flashes, it is necessary to bond all metal objects in the boat. Bonding keeps everything at the same potential, reducing the risk of side flashes, and it includes all deck hardware, chain plates, lifeline system, pulpits, steering system, and electronics. A #8 wire should be used for this purpose. Be sure to keep the electrical connections clean on these fittings, as well as all the others in the system, especially as time goes on. If the connections corrode, resistance will increase and the efficiency of your system will be reduced.

What To Expect from a Hit

If your dissipating and bonding systems fail and you take a hit, the damage sustained is a function of the quality of your bonding system and the magnitude of the strike. We have heard and seen results ranging from a few areas of burnt paint to the loss of every piece of electronics gear (including unwired handheld electronics).

The more resistance the lightning bolt encounters on its path to ground, the higher the amperage, and the destructive energy, will be. This energy has been known to melt rigging, as well as to blow through-hull fittings away from the hull skin and to explode bonding plates.

Obviously, it is best to avoid the hit entirely. If that isn't possible, get the current to ground with minimum resistance and damage.

Can You Protect Your Electronics?

One of the side-effects of a lightning hit is the creation of huge amounts of magnetic energy. This can be felt sometimes hundreds of feet away. Since most integrated circuits are sensitive to magnetic force, they need to be protected inside of what is called a Faraday cage. This is a simple box made from metal. Wrapping electronics (or spares) in tin foil may help. Also, disconnecting electronics before a hit takes place will reduce the odds of damage, although a big hit will eat even disconnected gear (unless it's in a Faraday cage).

Our friends Al and Beth Liggett took a hit while moored in Guam. They weren't aboard *Sunflower* at the time, but when they returned they found the VHF antenna gone. The wind instruments and tri-color light at the masthead were still okay, however. Down below, the VHF, pilot, engine alternator, Satnav, stereo, and some of their LED signal lights were fried. Yet other items like normal lights, engine starter, and laptop computer escaped unscathed. They lost a couple of breakers on the main panel; some plastic on the upper lifelines was fried; and the stern light was blown. *Sunflower*'s structural integrity, however, was sound. There were no problems with through-hull fittings.

Metal Boats and Lightning

One of the advantages of a metal boat is that it offers a huge amount of area in contact with the sea to both relieve static charge and dissipate lightning energy. In fact, I have yet to hear of a metal boat being hit.