NAVIGATION

There's nothing like the feeling of landfall after a long ocean passage. Above is the northwest corner of Nuku Hiva, in the Marquesas Islands at the northeastern end of French Polynesia.

The details of navigation are available in many excellent texts. Here we want to go into the logic of this art, illustrating the rewards of doing it right and the risks of doing it wrong.

Careful navigation is, after all, the cornerstone to a safe passage.

It wasn't too long ago that navigation was treated as a black art. The "secrets" of the profession were closely guarded, and less than 25 years ago the mysteries of celestial navigation were considered difficult to grasp. This knowledge was a prerequisite for crossing oceans, and acted as a form of cruising birth control. Anchorages were a lot less crowded.

In order to learn celestial navigation (which was not as hard as some would have led us to believe) you had to first understand and practice basic piloting. The piloting skills were what kept you out of trouble between celestial (or other) fixes.

Then along came the first inexpensive satellite navigators. By the mid-1980s the cost of these was down in the same bracket as a windvane steering system, and everybody had one.

Being freed of the necessity of learning celestial navigation meant more folks were heading out over the horizon. Since the satnav typically only gave a couple of fixes each day, you still had to know piloting.

Soon the GPS became ubiquitous, with its ability to tell us our location at any given moment. No waiting for a clear horizon and observable celestial body, no waiting for a satellite pass, just look at the screen and...well, you know the story. Hook this up to a plotter and suddenly the *apparent* need for piloting is gone.

But is it? We would argue that even today piloting and celestial skills are necessary. You can be sure that at some point the electronics are going to fail—at which point these skills become invaluable. Besides, they are fun, give you something to do on watch, and add to your sense of accomplishment in a well-sailed passage.

MOONSHADOW

Before going into some of the details of navigation we want to pass along the experience of a good friend of ours, an experienced sailor who learned some basic lessons the hard way.

George Backhus purchased *Moondshadow* several years ago from her original owner, Mike Gluck. A Deerfoot design of ours, this 62-foot (19-meter) vessel was built conservatively, and engineered to go places.

George sailed her out from the East Coast of the US to the San Francisco Bay area. After this "get acquainted" cruise he went on to sail to Hawaii and back and then down to Mexico. Finally the urge to visit paradise was too strong to resist, and *Moonshadow* was off from Mexico to the South Pacific.

An uneventful passage to the Marquesas led to a wonderful visit in these awe-inspiring islands.

Eventually, however, the lure of the next island group and the desire to discover what was beyond the horizon coaxed them off for the Tuamotus.

Up to this point, the risks from navigational errors were modest. Almost all of the passaging that had been done by George and *Moonshadow* ended with easy-to-spot landfalls, with good radar returns. If he was off on his piloting a bit, he would know it before he got into danger.

Landfall in the Tuamotus

Moonshadow made her landfall in the Tuamotus at Takaroa after 57 hours of powering—the tradewinds having taken a temporary vacation in this El Niño year.

As atolls go, Takaroa is one of the better places to start the learning curve. The barrier reef has almost total cover of palm trees, making it easy to see at some distance, with no detached segments of reef. Also, the trees make for a good radar return.

The pass is easy to enter, although the dog-leg at the end into the lagoon will get your adrenaline flowing the first time you go through.

George and his crew of Eric, Fred and Cort were made to feel at home in the best Tuamotian style.

Heading West

In the era before GPS cruisers planned their passages carefully in the South Pacific. Moonlight was a major factor, as was the weather (we tried to avoid passaging when the trades were disturbed, as this made for poor visibility and a lack of observable celestial bodies).

Departures were timed so that we'd hit the difficult navigation points in daylight.

But with GPS, everyone, ourselves included, has become a bit more complacent.

George and his crew decided to head next for Manihi. They'd been told that the pass was easy to get into, and with an early start they figured they would be there by late afternoon.

They awoke to find the trades had returned.However they did not clear the pass until 1115 and it soon became obvious that, despite carrying a full-sized 2.2-ounce spinnaker, they would not make Manihi before dark.

The foundation of all navigation rests on your piloting ability, regardless of the type or sophistication of electronics.

Even with the most user-friendly and reliable chart plotters, your piloting skills are what will keep you out of trouble. They provide that sixth sense about when things are right or wrong. For example, if the chart plotter seizes up the computer, you'll need piloting skills to recognize the problem.

It is easy to get complacent with your navigation, given that the GPS lets you know where you are at all times. This is something that we fight all of the time. Plotting on an hourly basis, backing up our GPS with radar, the depthsounder, or a visual observation at times seems like overkill.

But it is easy to make mistakes. It has happened to everyone that cruises. Sometimes you catch the mistake in time. In other situations, the mistake catches you.

It is the near-misses that we've had in the past which help to keep us vigilant in the present.

George Backhus comments on leaving Takaroa:

"We were late getting out through the pass, and it is important to note that the tidal predictions were off by more than three hours. When we went to leave at 0800, there was a veritable river flowing out of the lagoon, so we waited at anchor near the "hard left turn" until we could see the flow had stopped before we motored out at low slack water. One other factor worth mentioning is "cruising on a schedule." While I had no particular schedule, most of my crew did, so we may have pushed on when we should have laid off. "

Moonshadow's projected course is shown on the chart below with the dashed line. They had a radar bearing on Ahe to confirm their GPS position about the location shown where the solid line diverges.

The course that the navigator, Cort, issued is the continuation of the dotted line. Due to miscommunication, however, the actual course was much lower as shown by the solid line. The arrowhead indicates the actual GPS position which Cort transposed further north.

This left them with the option of heaving to for the night or continuing on.The decision was made to alter course to the northwest and head for Rangiroa.

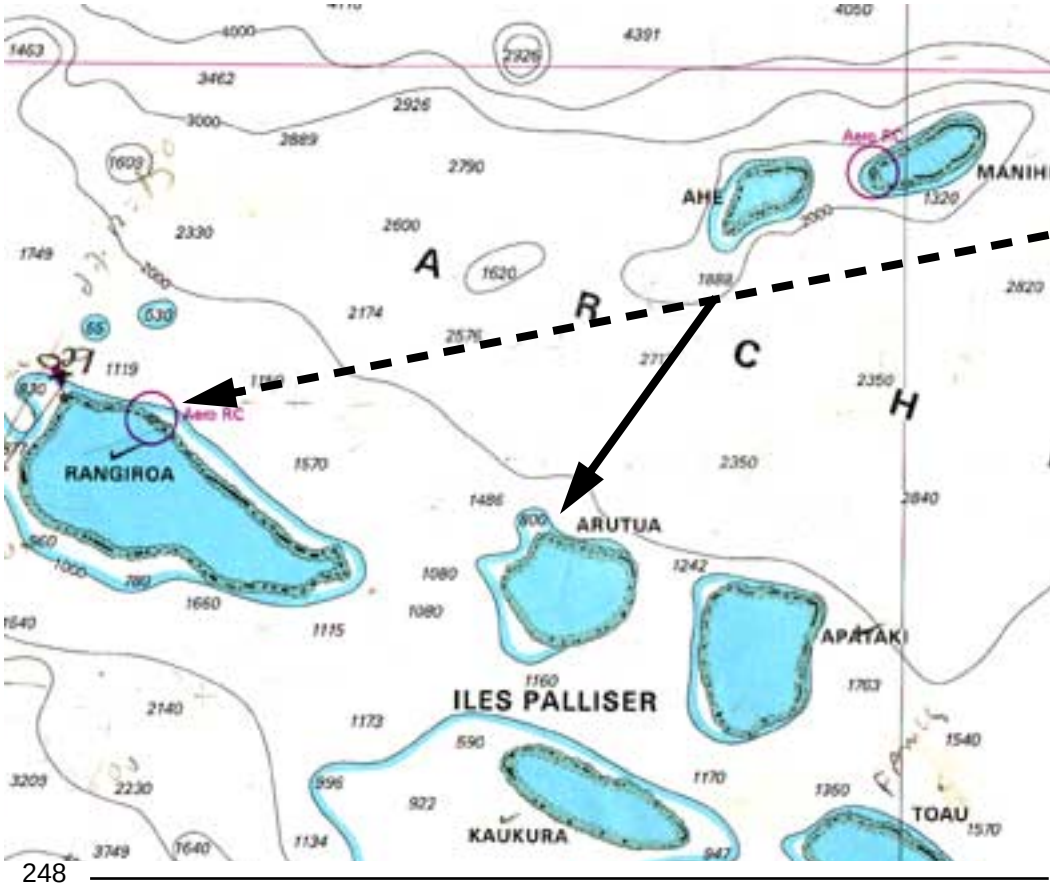
Being an El Niño year the normal tradewind circulation had been fitful, laced with frontal passages and lots of squalls. The squalls in turn made it necessary to keep the hatches dogged so it was quite warm below. The squalls brought major shifts in wind direction and velocity, and nobody was getting much sleep.

Cort plotted a waypoint which would allow them two miles of clearance on the southwest corner of Ahe. From there it was a clear shot towards Rangiroa.

A quote from Cort's journal which appeared in *Latitude 38* picks up the story.

After dark, I felt uneasy about being so close to the islands and reefs, so I checked and rechecked our progress as we passed Ahe. I turned on the radar for positive identification and to monitor the squall activity, which had increased. We enjoyed dinner as we passed to the southeast of Ahe, seeing some village lights in the distance.

Our new course for Rangiroa was 243-degrees. I did a last

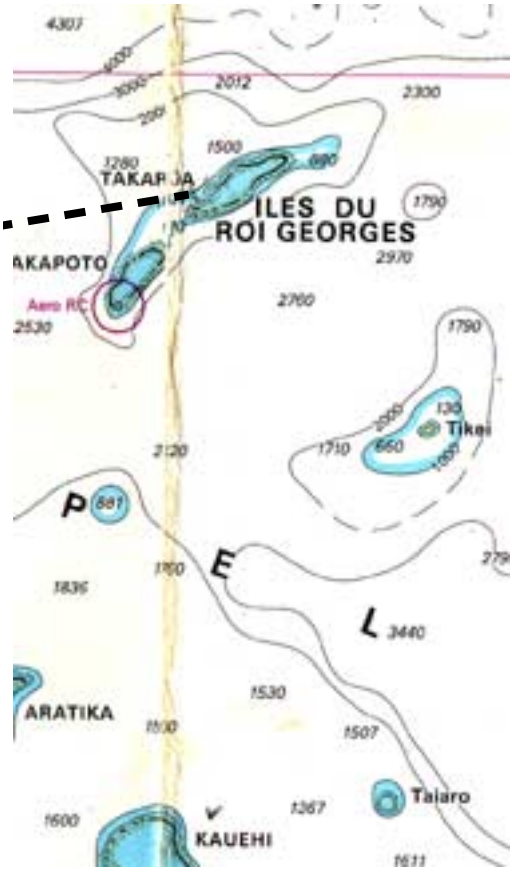


plot before hitting the sack, and told helmsman Eric not to sail below 210-degrees for any length of time as there was an island to the south—albeit way to the south—that could become a problem.

Change of Watch

At 0205 Eric woke me to explain it was squally out and they needed me on watch two hours early. George told me he didn't want Fred on watch alone in these tricky conditions and we'd be jibing in the next lull. Since George and Eric were dead tired, George wondered if I wouldn't mind starting my watch right away. I told him no problem and that I'd check our position.

We were at 15-degrees, 11-minutes south and 146-degrees, 48-minutes west. In my stupor, I erroneously plotted the 11 minutes of latitude to the north—as if we were still in the northern hemisphere—instead of to the south. This incorrectly plotted position put us six miles to the south of our rhumbline course to Rangiroa. The position seemed reasonable to me, as the wind clocking to their east and the squalls driving us south meant we'd been having trouble holding course.



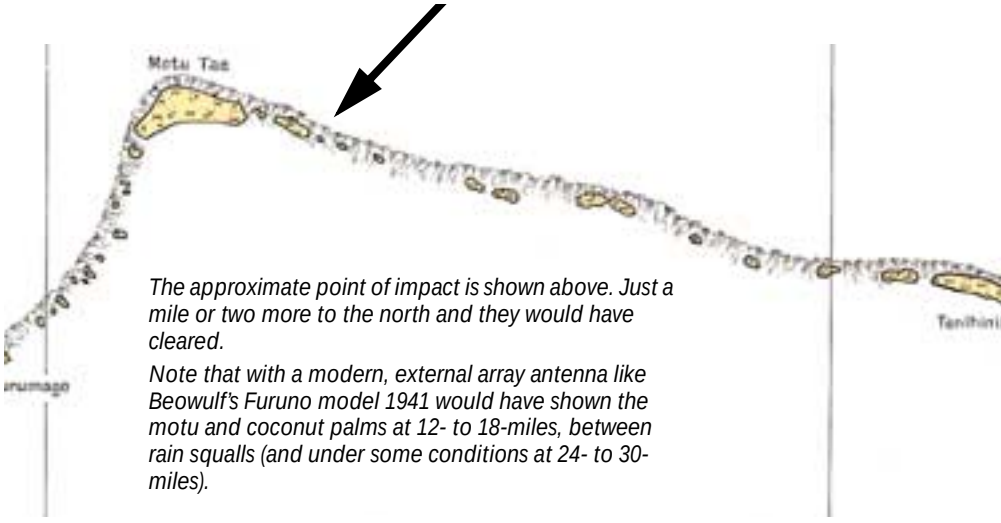
The weather pattern experienced by *Moonshadow* and crew was typical of what is called a tradewind convergence. The squall activity was also what you would expect to encounter as the convergence line passes over.

Back to Cort's narrative:

This is when George told me that they were steering 210-degrees, or 36-degrees off the course we should have been steering. Somehow the message not to steer that low for any length of time hadn't been understood.

George picks up the story.

The trades were blowing 20- to 25-knots with stronger gusts in the squalls. We were running downwind with the 130-percent jib to leeward on port jibe with an apparent wind angle of 140-degrees. Seas were 6- to



The approximate point of impact is shown above. Just a mile or two more to the north and they would have cleared.

Note that with a modern, external array antenna like Beowulf's Furuno model 1941 would have shown the motu and coconut palms at 12- to 18-miles, between rain squalls (and under some conditions at 24- to 30-miles).

More from George Backhus:

"Regarding the issue of having a watch forward, in fact, Cort, Eric and I were all sitting in the cockpit when we struck the reef. A combination of being behind the windshield of a dodger, the lack of any moon or star light and the rainy/suspire conditions brought visibility down to two boatlengths at best. Even after we hit the reef, it wasn't until the squall cleared that we could see the palm trees ashore. We actually thought we had found an uncharted reef in the middle of the channel!

"Post Script: Even though the radar was not damaged in the grounding, I have replaced it with the latest Furuno 36 mile CRT unit. I always use it at night, when the visibility is poor or when we are making landfall. I like the 'Watchman' feature for saving amp hours and giving me a tone to remind me to check it every ten or twenty minutes."

8-feet. (1.8- to 2.4-meters), and we were doing a steady 9- to 10-knots.

There were three of us in the cockpit and I was waiting for a lull in the wind to jibe over to starboard. Suddenly there was a huge impact, and before we could react there were several more bangs as the surf started pushing us onto the reef.

It happened so suddenly there was no time to react. *Moonshadow* quickly came to rest about 200-feet (65-meters) in from the edge of the reef. She was heeled over at a 50-degree angle, just outside the surf line.

The crew set off their EPIRB, then contacted another yacht, *Walkabout*, on the VHF.

To find out the details of how *Moonshadow* was pulled off Arutua, see page 579. For now we want to discuss what went wrong.

Obviously this is a difficult subject for George to discuss. *Moonshadow* is like a family member to him. Although she was insured, he felt terrible about what had happened to her, and was no doubt distressed by the fact that such a small margin in any number of events would have turned this into a close call rather than something requiring a sea-going salvage tug.

Our initial discussions with George were over the phone right after he'd returned to the States to deal with the insurance issues and decide on repairs. A month later, Linda and I had the pleasure of meeting George in Sausalito aboard *Beowulf*, where we were visiting for a few days.

What Went Wrong

Linda and I were interested in the events which had lead up to *Moonshadow's* stranding, and George was kind enough to indulge our questions on what he would have done differently if he could do it over again.

"The mistake I made," he said, "was to let my guard down. We'd just spent a lot of time on the open ocean where we only needed to plot our position once a day. And, if we were out of position a few miles, one way or the other, it made no difference. I should have insisted that whomever

There is no sadder sight than that of a beached boat.

In this case, the story had a happy ending on two fronts. First, Moonshadow was eventually towed off without major damage and is cruising once again.

Second, it was the first time we've had the opportunity to see how our "reef insurance" form of construction has worked. All of our boats have had extra heavy scantlings in the turn of the bilge (or a double bottom) to give additional protection. And seeing what happened to this 16-year-old design was very enlightening for us.

was on watch make an hourly plot this close to land. That way, we'd see right away if an error was made."

I was curious if there'd been any warning from the sea before they hit.

"Looking back on it" George went on "the sea had become somewhat confused. But with the squalls around and the wind shifts, I didn't categorize the change in sea state as something to worry about. The next time we will all be a lot more alert!"

Moonshadow has a first-generation Furuno 36-mile raster-scan radar, part of her original equipment from the mid-1980s when she was built. We asked George if this was running while they were on watch. His reply was that they had not been using the radar because between sea clutter and squall activity, it was not useful in seeing the atolls. In good conditions, however, it would pick up an atoll at six to eight miles.

Lessons learned:

- ❑ Plot position hourly so any discrepancies or mistakes show up immediately.
- ❑ Make sure all the crew understand the navigational issues and study the chart.
- ❑ Have someone double-check navigation in tricky situations.
- ❑ Be alert to changes in sea state. Investigate any changes, and double-check position.
- ❑ If you are not 100 percent sure of your position vis-a-vis danger, heave to until you are certain, or you have good visibility.
- ❑ Always keep a watch forward.

A modern set, especially one with an open-array antenna, would see the palm trees at 12 or more miles, even with a large sea running.

In closing, George makes the following points:

It is important that everybody learn from the mistakes and misfortunes of others. The factors contributing to *Moonshadow* hitting the reef were squally weather, poor visibility on a moonless night, some miscommunication between the crew, navigational errors, and fatigue.

With better procedures in place–such as having at least two people doing the navigation in hazardous waters, plotting our position at least once an hour, and having standing orders put in writing–the whole thing could have been avoided. The shock of this event will be carried by the crew for a long time, and you can be sure that "constant vigilance" will be my motto from now on.

At least I was fortunate in that nobody was injured and *Moonshadow* appears to have proved to be nearly bulletproof.

Moonshadow was eventually shipped from Papeete, Tahiti to Auckland, New Zealand, via freighter where the Salthouse yard repaired and ugraded her. Three years later, as we write this, George and *Moonshadow* are cruising in Fiji.

NAVIGATION IN THE AGE OF GPS

The advent of GPS has changed much about cruising. Gone is that sense of doubt, even dread, of not knowing *exactly* where you are. The ability to constantly know your position is the most wonderful thing that has happened to voyaging, bar none.

But even with this data, mistakes are still made, as we've just seen from the *Moonshadow* story. The GPS gives a very precise position. The question then becomes, how do you use this information in the safest, most conservative manner?

Chart Accuracy

All the GPS accuracy in the world doesn't do us much good if the charts we are using are off a bit—and they are. Not all charts are inaccurate, but enough are so that you can never totally rely on your GPS-to-chart-transfer to determine your precise location.

This problem is more widespread outside of major industrial countries, but to be safe, you must assume it exists everywhere, unless you can confirm from some other source that the chart is accurate.

During the winter of 2000 we took *Beowulf* from Southern California through the Panama Canal, and then through the West Indies. In the spring we ended up in New England.

In California the charts were right on the money. Our chart plotting system (which we'll discuss starting on page 274) would show us the correct side of the dock to which we were moored.

Heading down the coast of Mexico we made four brief stops. In each case the GPS position was within an eighth of a mile or so of our actual