WILEY NAUTICAL

Lifeboats

Pencil, Paper and Stars

The Handbook of Traditional & Emergency Navigation

ALASTAIR BUCHAN

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Contents

An excellent art

Navigation is that excellent Art, which demonstrateth by infallible conclusions, how a sufficient Ship may be conducted the shortest good way from place to place, by Table and Travers.

John Davis, *The Seaman's Secrets*, 1594

Electronics took its time killing traditional navigation. The first hint of its intentions was in 1906 when the Italians Bellini and Tosi found how to determine the direction from which radio signals were transmitted. By the end of the 1940s radio navigation had grown to include Consol, Decca, Loran-C (the Russians had their version called Chayka), and Omega, the son of a 1940s development called Radux and the first worldwide positioning system. It even had its own differential system for improved accuracy and was switched off only in 1997. It is hard to believe that only 30 years ago hi-tech, electronic navigation for most yachtsmen was donning a set of headphones and waving a glorified transistor radio vaguely towards a radio beacon in the hope of obtaining a bearing on a magnetic compass that could be plotted on a paper chart.

The introduction of inertia navigation was ignored by the leisure sailor and the arrival of satellite navigation gave no hint of its future dominance. With only one, often doubtful, fix every half hour or so and a cumbersome, parsimonious display, the Transit system hardly seemed worth the expense and certainly no reason to throw away your sextant.

Navigational calculators were expensive and rarely found on yachts. A few enthusiasts wrote simple navigation programmes for the handful of calculators that could be persuaded to remember a few keystrokes. Primitive by today's standards and less than user friendly, these were the ancestors of those managing today's GPS sets.

There were no digital charts. Positions were plotted on paper, just as they had been since the Egyptians invented papyrus.

Navigation stubbornly remained more art than science, heavy with traditions. Innovation, when finally accepted, came in small, genteel steps building carefully on what had gone before. The sextant's lineage goes back over 2,000 years to the astrolabe. Robert Hooke showed the prototype of the modern sextant to the Royal Society in 1666. Isaac Newton described his notion for a double reflecting sextant to a Royal Society meeting in1699. Both ideas sank without trace. It was 1731 before Thomas Godfrey in America, and John Hadley, a London instrument maker, simultaneously and independently re-invented the double reflecting quadrant. In the summer of 1837, over a century later, Captain Thomas H Sumner accidentally developed the celestial position line but it was 1875 before Captain, later Admiral, Marc St Hilaire cracked the maths behind the altitude-difference method of establishing a position line, and the middle of the 20th century was approaching before short method tables were published.

The rotator log replaced the medieval log ship towards the end of the 19th century. Around the 1930s the micrometer drum superseded the vernier scale on sextants. In the late 1950s, the echo-sounder finally took over from the lead line. Hardly revolutionary progress. Well into the 1980s, navigators like Cook or Bligh would have had no difficulty in coming up to speed on the latest techniques and then showing us how it should be done.

In an overnight coup, the microchip deposed centuries of tradition and changed everything. Watches, so accurate that in the past they would have been cherished as top end chronometers, became so cheap that they were disposable. LCD screens provided detailed information in easily understood language that superseded the analogue display. Plotters, digital charts, digital compasses, radios, autohelms, radars, and, soon after it went fully operational in 1995, GPS, all quickly became commonplace on the smallest yacht.

The computer in every instrument began networking with every other, and displaying more information than any reasonable navigator was able to use. Modern navigation requires no prior knowledge or skill. If you can send a text message then you can navigate. The distinction between coastal and ocean navigation, novice and

expert, amateur and professional, vanished. Knowing why or understanding how it is done is unimportant – irrelevant. Since May 1998, the United States Naval Academy has stopped running courses on celestial navigation. The sextant is dead. Long live the microchip!

There is a downside. Electronic navigation makes the divine right of kings look like democracy in action. Instruments talk, but only to their equals and then announce decisions set in tablets of stone. Their proclamations are assumed accurate to several decimal places and their absolute reliability is unquestioned. Cross checking by traditional methods reveals only gross errors and since computers never err, why bother? So we no longer cross check, and age-old knowledge is forgotten.

But what happens when your electronic wizardry abdicates and leaves you alone with silent, blank screens upon an empty sea? After checking its connections and giving an encouraging thump you can do little more. Modern instruments are impervious to user repair. Why they fail is irrelevant. The fact is you are in the middle of nowhere and want to go home. The question is, how?

The kneejerk, textbook solution of digging out a paper chart and sharpening a pencil works brilliantly in the clubhouse, but unless you remember long-forgotten skills, have a clockwork log and magnetic compass you are going nowhere. Bar room knowledge may take you clear of the yacht club but before long you won't know where you are, how you got there, or how to return in time to buy your round. You need 'Crash Bag' (emergency) Navigation. The chances are it will get you to the bar on time and with a good tale to tell.

This book explains the principles involved in finding your way without instruments, and how to make simple instruments from materials you have on board. But you will find no answers, simple or otherwise. No formulaic solution can cover every situation. It is up to you to use the principles and techniques described in this book in a way that meets your circumstances. We modern navigators may not be as accurate, skilful or confident as those who learned these techniques through a long apprenticeship and used them every day, but we would have to be really slow not to learn enough to dig ourselves out of a hole and reach port.

Another kind of sailing

. . . three kindes of Sayling, Horizontal, Paradoxal, and Sayling upon a Great Circle
John Davis, *The Seaman's Secrets*, 1594

The techniques that once made piloting, dead reckoning and celestial navigation separate skills, are history. Nowadays navigation depends on accessing detailed and accurate data provided by an array of electronic devices that do not care if you are inshore, offshore, or in the middle of nowhere. But take these clever instruments away and the flow of data dries up, and we are lost unless we find some other way of acquiring the information that will allow us to continue on our way.

It can be done and has been done for thousands of years. Sailing without electronic instruments demands more of the navigator. He or she is no longer a button pusher but a combination of a mathematician, astronomer, biologist, meteorologist, cartographer, and geographer. It is daunting, but the biggest challenge is in acquiring or re-acquiring a mindset for another kind of sailing.

Positive Waves

Always think positive. A lack of instrumentation and charts is not a disaster. You are not inventing the wheel. Sailors have been navigating without instruments far longer than they have with them. They have even sailed round the world without them. Take comfort in the fact that you are not the first.

Accept Uncertainty

Be happy living with uncertainty. GPS has accustomed us to pinpoint our positions accurately all of the time, anywhere and everywhere. At one time, knowing your

position to within a handful of metres was only possible if you had correctly identified and taken bearings or transits on several charted features. Unless you were anchored, the position had a half-life measured in minutes. The further you travelled the less certain your position. You were not lost, but where you were became an educated guess rather than a certainty taken to several decimal places.

Make Mistakes

Uncertainty means your position contains unknown errors. The only certainty is that you are not where you think. Sometimes a known error is better. You still do not know your precise position but at least you are making mistakes of your choosing.

Picture This

Digital navigators have been known to carefully log their vessel's GPS coordinates and minutes later run aground. They have failed to relate this information to the real world. Always doubtful of his position, a Crash Bag Navigator must remain spatially aware and keep a plot running in his head. In other words, he must have a mental picture of where the boat is in relation to the world about it.

You do this all the time. When travelling between home and work, at any point on the journey you can point towards your home, destination, or places in between, without any hesitation. You know where you are without looking at a map.

Similarly, the Crash Bag Navigator knows what course he's steering and what speed he's making. He always has in mind a fair approximation of the boat's position and its relationship to landmarks and hazards. He uses as many independent ways as possible to check his direction, position, and speed. Each check gives a slightly different answer but they should all lead to more or less the same position.

Keep It Simple

At one time, nautical ambitions more or less kept pace with navigational skills. You dared not sail across the bay and lose sight of land without being sure you could find terra firma again. Ocean passages waited until you had mastered astro-navigation.

With GPS, you can buy a boat on Monday and start out across the Atlantic on Tuesday. The occasion when you lose your instruments may be your first time at sea without their comfort blanket around you.

It is a steep learning curve. Keep it simple. Always chose the easy option. Prioritise the tasks facing you. Do them one at a time, deliberately, slowly, and check progress before moving onto the next task.

Proper Preparations

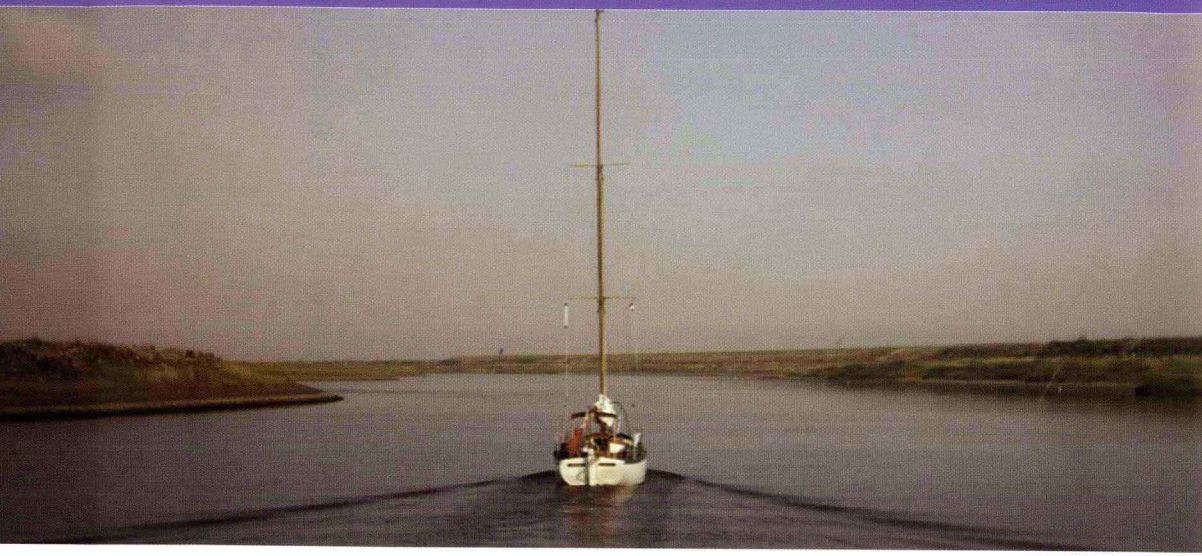
It is a fundamental truth that performance in any field is directly proportional to the preparations and training made beforehand. Lay the foundations for Crash Bag Navigation before you need it. You should not be trying it for the first time five minutes after your instruments die. Every passage plan should be prepared and made bearing in mind the possibility that Crash Bag Navigation might be needed.

Although there should be no difference between theory and practice, it would be prudent to take every opportunity to practise the ideas described in this book. You not only gain proficiency and a good understanding of the degree of accuracy you can expect, but learn to allow for inaccuracies.

If you live by the plotter then it is important to have an up-to-date written record of your position in a paper log, or as a plot on a paper chart. Without this you will have to guess where you are when you begin Crash Bag Navigation. It also helps to have written down (or printed out) the coordinates of the waypoints you intended to use.

Greater than the Whole

Although this book deals with topics separately, the trick is in putting them together. The sum of the parts is greater than the whole. Sometimes an insignificant, almost overlooked and apparently irrelevant detail in the distant outfield completes the picture. The Crash Bag Navigator is a ravenous and omnivorous collector of data.



The first navigators

Once cavemen developed a navigational methodology it was not long before this methodology became formalised with certificates of competence, and a range of gadgets all promising to make it easy. It would be wrong to think of the early navigators as uncivilised, uneducated, unsophisticated, unqualified and fearful of losing sight of land.

The distribution of finds of Irish Bronze Age gold ornaments showed that there was a healthy trade between Ireland, mainland Europe, Scotland and Denmark. Any way in which you retrace those routes involves some wild water sailing and serious navigation.

In the fourth century BCE, Herodotus wrote that when you were in 11 fathoms (this is a misprint for 100 fathoms) and found yellow mud on the lead then you were one day's sail from Alexandria. Mud from the Nile extends about 60 miles offshore, and soundings of 100 fathoms puts you some 50 nautical miles offshore. Coincidentally, the Minoans had a harbour at Knossus on the south coast of Crete whose only purpose was to trade with Africa, a good two days' sail across open sea.

Around 500 BCE Hanno, a Carthaginian, took 60 ships down the west coast of Africa, colonising as he went. He reached the region that is modern Sierra Leone. Even earlier, in 605 BCE Pharaoh Necho II, upset by failure in his war against Nebuchadnezzar and keen to secure his place in history, commissioned a Phoenician fleet to sail round Africa. They sailed down the east coast, round the Cape of Good Hope, up the west coast and back along the Mediterranean to Egypt.

This is a voyage of about 16 000 nautical miles and it took three years. Considering they stopped ashore for a few months each year to grow crops, they were either putting up eye-watering performances, or they had the capability to make long offshore passages, navigationally unequalled for many centuries.

Around 340 BCE another Phoenician, Pytheas of Massalia (present-day Marseilles) explored the Arctic Ocean and reached Utima Thule. Wherever that was, getting there involved offshore passages in some of the world's most inhospitable seas. Pytheas also invented an accurate method of calculating latitude using a calibrated sundial, theorised over the relationship between tides and the phases of the moon, and attempted to determine the position of true north.

On his return he documented his voyage in *Peritou Okeanou* (On the Ocean), which was lost. Fortunately, other writers drew upon it and we know Pytheas estimated the coastline of Britain to be 45,000 stades. Using the best guess we have about the length of a stade Pytheas made Britain's coastline 4,800 miles as against our figure of 4,710 miles.

In 146 BCE, Eudoxus of Cyzicus on his second voyage from Egypt to India was blown ashore below Cape Guardafui (then called the Cape of Spices) in Somalia off the Horn of Africa. There he found a wooden prow, carved with a horse's head, floating in the water. On his return to Carthage, he discovered that this was identical to those found on ships from Cadiz and Morocco. Did some navigator make it into the Indian Ocean a thousand years before Vasco Da Gama?

In about 100 BCE, the Roman geographer Statius Sebosus claimed that sailing for 40 days from the Gorgades brought you to the Hesperides, the legendary islands beyond the Atlantic Ocean. Some claim that the Gorgades are the Cape Verde Isles. If so, the next stop west is the Caribbean. On his third journey to the New World it took Columbus 33 days to sail between the Cape Verde Islands and the Caribbean. Was someone making transatlantic round trips 1600 years before Columbus? If so, who? Sadly Sebosus does not say.

Pliny the Elder in about 50 CE related the tides to the phases of the moon. Sometime around 700 CE, the Venerable Bede, sitting in his monastic cell by the River Wear in North-east England, described the tides round the British coast. Bede's work was used by seamen into the 17th century.

About 4000 years ago, on the far side of the world, the Polynesians began sailing the Pacific. Polynesian sea lanes have been correlated to the flight paths of migrating birds. Some believe that Polynesian explorers were great bird watchers, and that when they set out to explore it was to discover land that they were almost sure was